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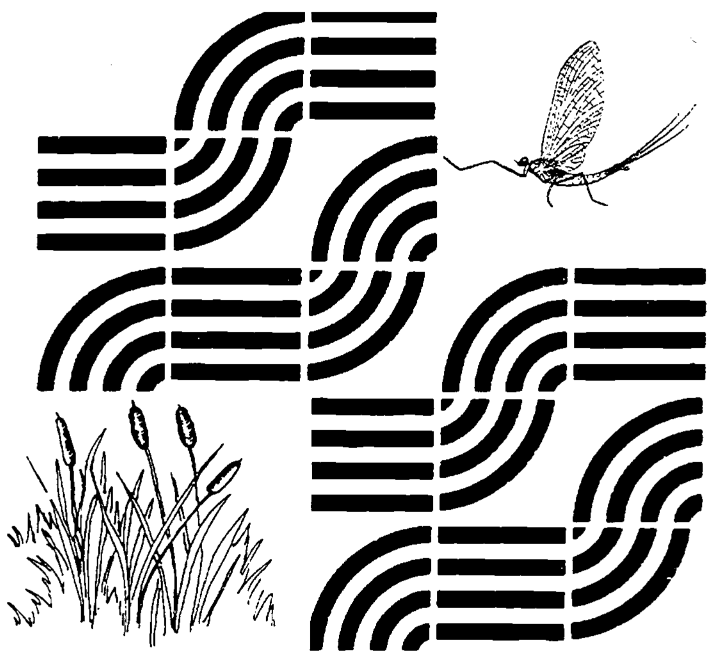
ABSTRACT

This guide comprises materials largely drawn from existing environmental education materials. The four major subject areas discussed mirror the Adopt-A Stream activities and include watersheds, nonpoint source pollution, and biological and chemical monitoring of stream conditions. The activities in this guide are grouped according to grade levels. K-5 activities include: (1) "Stream Journey (Introductory) K-2"; (2) "An Imaginary River (Watershed) K-2"; (3) "Are You Me? (Biological) K-2"; (4) "Water Wings (Nonpoint and Biological) K-2"; and (5) "Little Sprouts (Biological) K-5." Materials for grades 3-8 include: (1) "Picture Perfect (Nonpoint) 5-8"; (2) "Pollution Solutions (Nonpoint) 3-8"; (3) "Adopt-A-Stream Detectives (Biological) 3-5"; and (4) "Pondering pH (Chemical) 3-5." Activities for grades 6-12 include: (1) "How Big Is the River--Really? (Watershed) 6-12"; (2) "How Much Water Falls Here? (Watershed) 6-12"; (3) "Dragonfly Pond (Nonpoint) 6-8"; (4) "Name Those BUGS! (Biological) 6-12"; (5) "Adopt-A-Stream Chemical Monitoring (Chemical) 6-8"; (6) "Fertile Green (Biological) 6-8"; (7) "Watershed Walk (Watershed) 6-12"; (8) "Rolling Down the River (Watershed) 6-12"; (9) "Lethal Lots (Nonpoint) 9-12"; (10) "Adopt-A Stream Chemical Monitoring (Chemical) 9-12"; and (11) "Breathtaking (Biological) 9-12." (CCM)

Adopt-A-Stream Teacher's Guide

For grades K-12



Georgia Department of Natural Resources
Environmental Protection Division

October 1996

Adopt-A-Stream Teacher's Guide
Acknowledgments

Georgia Adopt-A-Stream wishes to acknowledge the contribution of volunteers working to monitor, protect, and restore Georgia's streams, rivers, and lakes. Working together we can protect our streams, one stream at a time. Indeed, only through all types of education can we truly create an ethic of environmental protection.

Georgia Adopt-A-Stream gratefully acknowledges Susan Hendricks, Gail Marshall, Chris Martin, Petey Giroux and Dee Shore who edited this guide.

Thanks especially to our summer intern, Tina Williams, for all her hard work putting this guide together.

And finally, thank you Sheryl Williams for all your support and hard work making this guide a reality!!

We sang the song that carried in their melodies all the sounds of nature - the running waters, the sighing of winds, and the calls of the animals. Teach these to your children that they may come to love nature as we love it.

Grand Council Fire of American Indians

What's the use of a house if you don't have a decent planet to put it on?

Henry David Thoreau

Anyone who can slove the probelm of water will be worthy of two Nobel prizes - one for peace and one for science.

John F. Kennedy

HELP!

Dear Teachers,

Thank you for your interest our teachers guide! This is our first edition and we would love your input. If you try out some of these activities, please fill out this evaluation and send it in. We will update the guide using your comments.

Lesson Plan Evaluated ____

Grade Level ____

	Poor		Moderate			Good			Excellent	
Overall Organization	1	2	3	4	5	6	7	8	9	10
Content	1	2	3	4	5	6	7	8	9	10
Graphics	1	2	3	4	5	6	7	8	9	10
Age Appropriate	1	2	3	4	5	6	7	8	9	10
Style	1	2	3	4	5	6	7	8	9	10
Technical	1	2	3	4	5	6	7	8	9	10

Suggestions for improvement:

Send to:

Georgia Adopt-A-Stream
EPD
7 MLK Dr. Suite 643
Atlanta, GA 30334

Adopt-A-Stream Teacher's Guide

Introduction

Georgia Adopt-A-Stream is a Department of Natural Resources, Environmental Protection Division program that promotes public awareness of water quality and citizen involvement in protecting streams, rivers, and lakes. Volunteers agree to adopt a section of stream or other water body for one year during which time they can increasingly learn about and protect local water bodies.

Since the program's inception in 1993, students and teachers have been one of Adopt-A-Stream's most active volunteer groups. Many teachers have asked for help in putting Adopt-A-Stream activities into a lesson plan format. This guide is designed for school groups actively involved in the Georgia Adopt-A-Stream program. We hope this teacher's guide will allow you to bring streams and water quality to your classroom and spark your students' interest in protecting our precious water resources. If there are any questions, please call Georgia Adopt-A-Stream at (404)656-0069 or (404)656-0099.

The activities in this guide are grouped according to grade levels. Four major subject areas mirror the Adopt-A-Stream activities: watersheds, non-point source pollution, biological and chemical monitoring of stream conditions. This guide has largely drawn from existing environmental education materials. Georgia Adopt-A-Stream gratefully acknowledges Project WILD, Air and Waste Management, AIMS(Activities Integrating Mathematics and Science) and the Izaak Walton League of America for their permission to use activities for this guide. We appreciate the use of these materials which will help encourage students to protect our natural resources.

Note:

Many of these lesson plans require a class to collect samples from nearby streams. It is vital to know the condition of the stream before sampling. Animal waste, agricultural runoff (pesticides, herbicides, etc.), industrial wastes, or sewage leaks can be hazardous to you and your students. If you find a stream with any of the above contaminants, a class should not collect samples in the stream or use proper precautions. Students should wear protective boots, gloves, and goggles when necessary or when stream conditions are unknown. In case of serious water quality problems, notify local or state authorities.

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Stream Journey

INTRODUCTORY

Objective: Students will discover the role of a stream in providing wildlife habitat and state examples of living and non-living objects at the stream.
Location: Outdoors (Teachers will need to determine a safe location and path for students to take to the stream)
Time Frame: 45-60 Minutes
Subjects: Science, Art, English, Language Arts
Level: K-2nd grade

Background:

Habitat - the type of surroundings in which an animal or plant species normally lives, consisting of food, shelter, air, water and space in a suitable arrangement. A home.

Living - An organism that performs biological functions, such as growing and reproducing. Examples include humans, fish, insects, trees, and grasses.

Non-living - unable to perform biological functions. Examples include water, rocks and dirt.

A stream provides habitat for a variety of living organisms. A fish has water to live in and rocks to hide under. Also, there are aquatic insects that serve as a food source for the fish. Mammals, such as beavers make their home in the stream, taking branches from trees to dam up the water.

Many non-living things in a stream go unnoticed. They are valuable to the stream and serve to provide habitat for the living organisms. For example, the rocks in the river are non-living. Salamanders and aquatic insects live under the rocks. The soil under your feet, water in the stream, and the air are other examples of non-living things in or near a stream.

In addition, streams and rivers provide drinking water, recreation and places to enjoy for people.

Materials:
Activity sheet
Sketch book or paper
Pencils and Crayons
Optional: Books or field guides related to aquatic insects, plants, fishes, reptiles, amphibians, and freshwater wildlife

Preparation:

Teachers will need to locate a safe path to take students to the stream. Check for any potential dangers (crossing a road, slippery streambanks). Have parents or aides with each group of 5 or more students. In addition, spread student groups out

along the stream so they all have areas to observe simultaneously and to reduce the impact of many children in a small area. Make sure to check if any student has allergies. (e.g. Poison ivy, bee stings, golden rod, etc.)

Note: It is vital to know the condition of the stream before sampling. Animal waste, agricultural runoff (pesticides, herbicides, etc.), industrial wastes, or sewage leaks can be hazardous to you and your students. If you find a stream with any of the above contaminants, a class should not collect samples in the stream or use proper precautions. Students should wear protective boots, gloves, and goggles when necessary or when stream conditions are unknown. In case of serious water quality problems, notify local or state authorities. Review "Think Safety" for field safety tips in the appendix.

Procedures:

Part One:

1. Before going to the stream discuss safety with the class. Set up the "buddy" system.
2. Discuss the following terms: Living, non-living, and habitat.
3. At the stream, have each group of students choose a spot in a designated area and draw examples of the living and nonliving things they can see. Because it is difficult for students to manage paper and books at the stream, the teacher and aides should carry the materials.
4. Bring students together and ask them to share their drawings with others in the class. Discuss how some of these interact with one another. For example, for plants, you might have students consider questions such as:
   What do plants need to live?
   Does anything eat the plant?
5. Have the students return to their area. Tell them to close their eyes, stand still and use only their senses of hearing, smell, and touch to add to their drawings.
6. Have the students share any new observations with the class and discuss how these additional items are related to each other and to the things already on their lists.
7. Have the students return to their area a final time to look for signs of humans impact. Signs may include trash, bottles, tires, roads, buildings, etc. Have the students draw what they see. Ask the students if they notice any difference in the signs left by people and those left by other animals.
8. Collect the sketchbook and crayons before part two.

Part Two:

1. Have the students spend time walking along the river. The teacher can have the students count the number of living and non-living things they see at the stream. On the "Stream Journey" sheet, mark the number of things the students see. Make sure to look under rocks, along banks, packs of leaves in the stream,

around logs, and in rocky areas (in or out of stream). The teacher may wish to pull rocks out of the stream to see if any aquatic insects are present.

2. Back in the classroom, review all the things the students saw along the stream and which category they saw the most things (e.g. birds, plants, rocks, etc.)
3. Have the students display their drawings on a board or classroom wall.

Questions:

1. What types of plants and animals live near/in a stream?
2. Give an example of a non-living and living thing at a stream.
3. Give an example of something left by humans.

Extension:

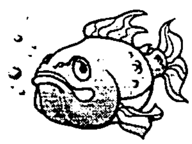
1. After returning to the classroom, you may wish to have students create a mural showing the animals, plants and nonliving things in the ecosystem. They could draw arrows to show the connections between parts of the ecosystem or connect related components of the ecosystem with pieces of yarn.

Based on Always A River, "Wetlands Safari".

Stream Journey

Directions: Have each student draw an "I" for every plant, animal, fish, or insect they see during the stream walk.

Location:____________________ Date:______________________

Living: Plants 	E.G. III
Insects 	
Fish 	
Reptiles/Amphibians 	
Birds 	
Mammals 	
Non-Living: Rocks/Soil 	
Water/Air 	

An Imaginary River

WATERSHED

Objective: Students will design their own miniature river system and be able to explain the concept of a watershed
Location: Indoors
Time Frame: 30 minutes
Subjects: Science, Art, Language Arts, and Social Studies
Level: K-2nd grade

Background:

Rivers are a result of many streams coming together to form a large flowing body of water. In a river, water flows from upstream to downstream due to the elevation of the land.

The water that flows through a river is a result of rain and/or snowmelt from the surrounding watershed and may be supplemented by groundwater sources. The size of a watershed depends on the elevation of the land. Where rain falls on a hill determines the direction the water will runoff into a stream. The areas of high elevation surrounding the stream will mark the outer edges of the watershed (see Appendix A-1).

In this activity, the students will take a piece of paper and place it at an angle. When blue paint is blown onto the page, the force of gravity causes the paint to run down the page. Just like the paint is subject to gravity, the water in a stream moves due to the elevation of the land and the force of gravity on the earth. As teachers, it is important to help students to understand the forces that cause a stream to move downstream.

Materials:
- White printing or construction paper
- Water soluble paint (non-toxic)
- Straws
- Newspapers and smocks for kids (old shirts)
- Road map showing the water systems (or topographical maps)

Preparation:

Depending on the thickness of the paint, water may need to be added to the paint. Have the student place newspaper where they will be working. Advise the students to bring a large, old shirt to wear as a smock.

Procedures:

Part One:

1. Give each student a white piece of paper and place a drop of paint on the top of the paper.
2. Each student then should hold the paper at an angle, watching the paint move down.

3. Ask why the paint moved down the paper. Explain that the force of gravity pulled the paint down the paper, just as it pulls a ball to the ground.

4. Explain that the same force, gravity, pulls water to the ground when it rains and also pulls waters down a hill or gentle slope. Gravity pulls the water from streams and rivers all the way to the ocean.

Part Two:
1. Give each student a white piece of paper and a straw. Place a drop of paint on the top of the paper.
2. Each student then should hold the paper at an angle, and have each student blow above the paint blot creating a branching pattern similar to a river and its tributaries.
3. Tell each student they have made an **imaginary river system**. Their breath served as the force of wind, which along with gravity, made the paint drain or run onto other areas of the paper.
4. Have the students name their river and the small streams.
5. Explain the following terms to the students: upstream and downstream. Ask the students to decide which way their river flows.
6. Explain how you tell which direction is upstream in a real river or stream.

Part Three:

Place a map showing rivers and streams on the tables between the students. Show the students where they are on the map.

1. Have the students look for a stream that looks similar to the "imaginary river" they have on their paper.

Part Four:
1. Have the students attach their drawings together (river to river) on the board. They have now formed a river basin.
2. Have the students give the entire river basin a name.

Questions:
1. Describe how a river looks.
2. Tell what makes water move in a stream.
3. How can you tell which direction is upstream or downstream in a real river?

Extensions:
1. Arrange a trip to a nearby stream. Read over "Stream Journey" before taking a trip to the stream.
2. Have the students draw in a sketch book the animals, plants, and insects they see at the stream.

3. Return to the classroom. Have the students cut out their drawings, discuss what they saw, and tape the drawings onto the river basin.

Based on Always A River, "An Imaginary River".

Are You Me?

BIOLOGICAL

Objective: Students will recognize various young stages of aquatic animals and match them with corresponding adult stages.
Location: Indoors
Time Frame: 60 minutes
Subjects: Science
Level: K - 2nd grade

Background:

Many animals look significantly different in their earliest stages of development, compared to adulthood. This is true for most aquatic insects. Many aquatic insects undergo metamorphosis. Metamorphosis means changes during growth. Some insects experience incomplete metamorphosis while others undergo complete metamorphosis. In incomplete metamorphosis, the insect's egg hatches to produce a nymph. Insect's nymphs have essentially all the features of adults. As they grow, the nymphs begin to resemble adults.

Insects that experience complete metamorphosis are characterized by eggs that hatch into larvae. The larva grows though several stages and then changes into a pupa. Pupae are usually encased in a protective cover for their next stage of growth. From the pupae emerges the soft-bodied, often pale-colored insects. They differ remarkably in appearance from their earlier forms. Gradually the soft body develops firmness and color. In complete metamorphosis, there is little resemblance between adult and earlier forms. Additional information on aquatic insects is located in Appendix C-1.

There are also remarkable similarities and differences between other aquatic animals in different life stages. The eggs of many animals hide their eventual form (alligators, turtles, birds). Pelican hatchlings, for example, may be the closest image of miniature dinosaurs to be found on the planet. Aquatic mammals often are easy to recognize. They frequently do not change as dramatically as some other animals in overall appearance as they grow from young to adult stages.

The major purpose of this activity is for students to recognize that there are differences in the life stages of aquatic animals as they grow. The students will increase their appreciation of the diversity of wildlife as well as their understanding of growth and change in animals.

Materials:

Picture cards (provided)
Pens and Crayons

Optional:
Paper to construct an aquatic ecosystem
Stapler

Preparation:

Make pairs of aquatic animal cards. The animals in the pair should be the same kind. (See attached pictures). Make a master for the students to compare cards by linking the adults and young pair together.

Procedures:

1. Introduce the following terms: young and adult (Include metamorphosis for 3rd graders).
2. Introduce the aquatic cards. Divide the class in two. Designate one half of the students "adults" and the other half "young". Give each student, according to their group, an "aquatic animal card". Attach the cards to a string loop so the pictures can hang around the student's neck.
3. Instruct the students to look for their "match". Have the students move around the room to find their match.
4. After the students find their "match", have the students check the "pair" with the answers on the master copy. If the match is incorrect, have the students try again. The students need to color the animal card.
5. Optional: Prepare a bulletin board or area on a wall to represent a stream where the animals live. Have the students place the colored card on the board where they belong. For example, the board or large sheet of paper should have a river, sky, trees and plants. The students will add the critters (cards).

Questions:

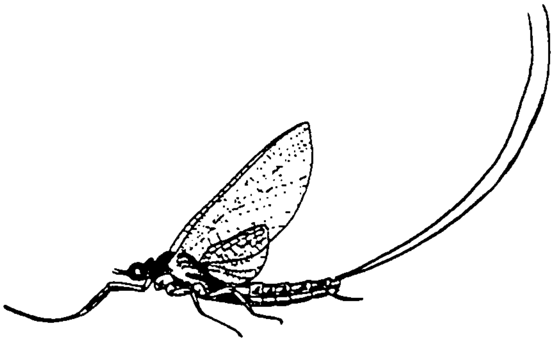
1. Pick two aquatic animals. Draw a picture of each animal as an adult and as a young animal.
2. Pick two aquatic animals. Where does the animal live in a stream? Where does it live when young? Where does it live when an adult? What changes enable it to live in a different place? (Answers may vary). Possible animals include birds, aquatic insects, etc.

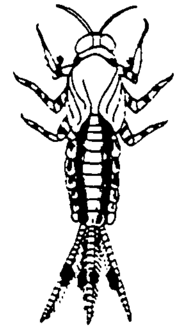
Extension:

1. Instruct the students to go home and find pictures of aquatic animals from a magazine. Bring pictures to school and place on the board.

Based on the Aquatic Project WILD, "Are you me?"

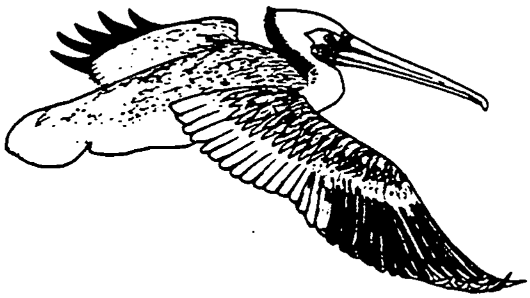
Mayfly





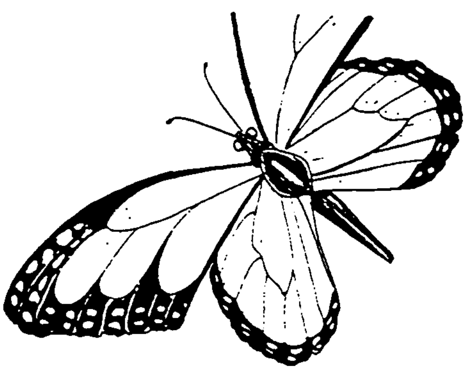
Mayfly Nymph

Pelican



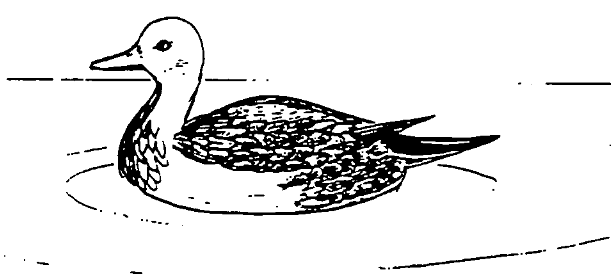
Pelican Nest and Eggs

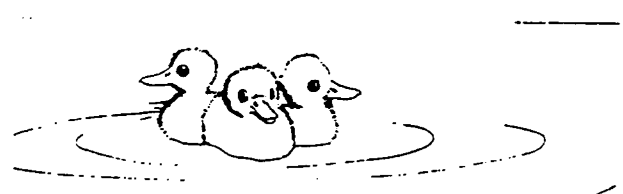
Butterfly



Butterfly Larvae

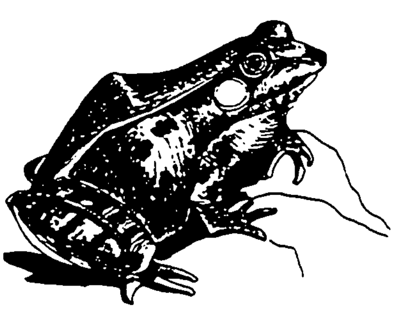
Duck

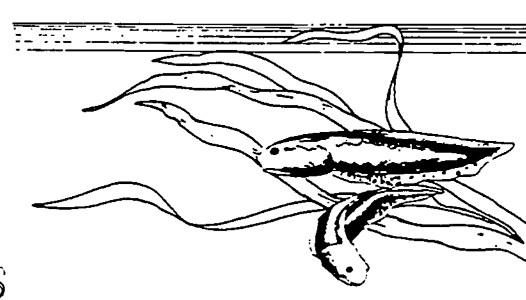




Ducklings

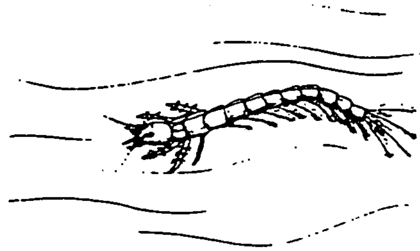
Frog





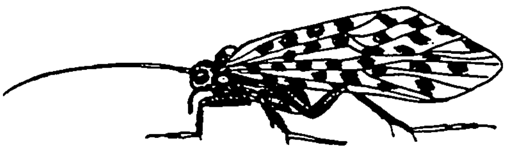
Tadpoles

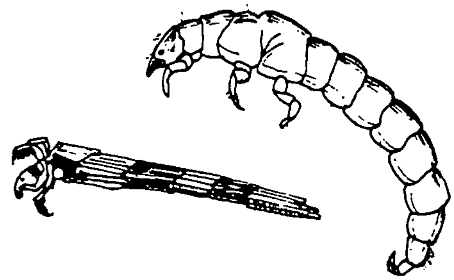
Whirligig Beetle



Whirligig Larva

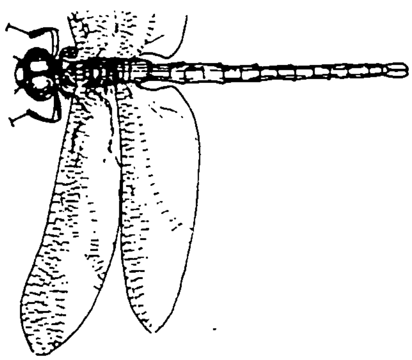
Caddisfly

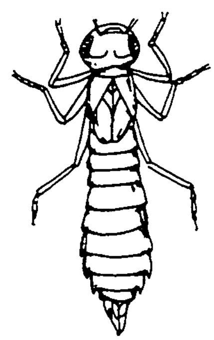




Caddisfly Larvae

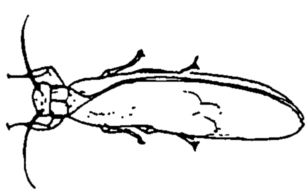
Dragonfly

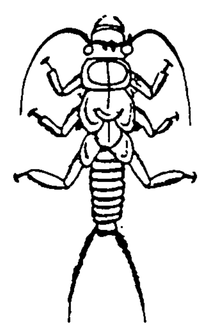




Dragonfly Nymph

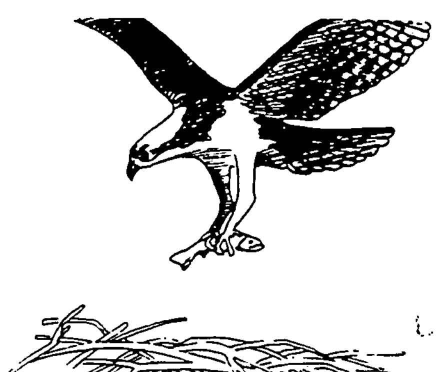
Stonefly





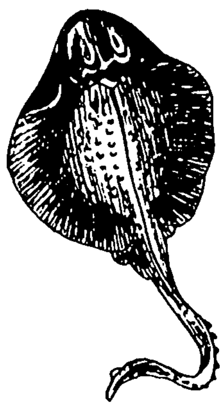
Stonefly Nymph

Osprey



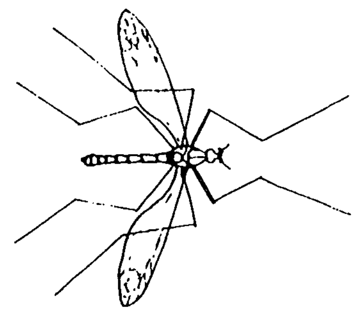
Osprey Hatchlings

Skate



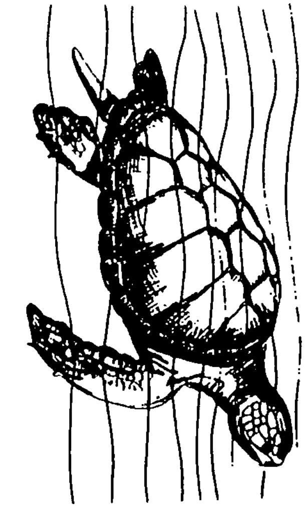
Manatee

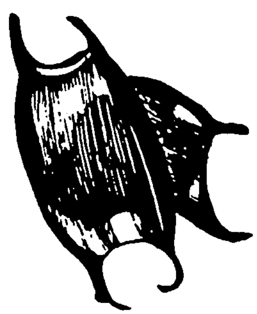
Cranefly



Sea Otter

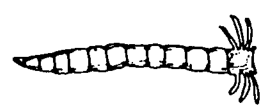
Sea Turtle





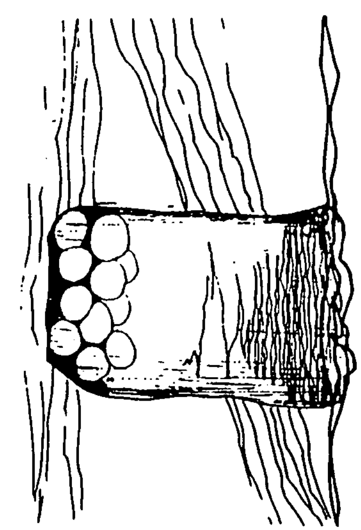
Skate Egg Cases

Young Manatee



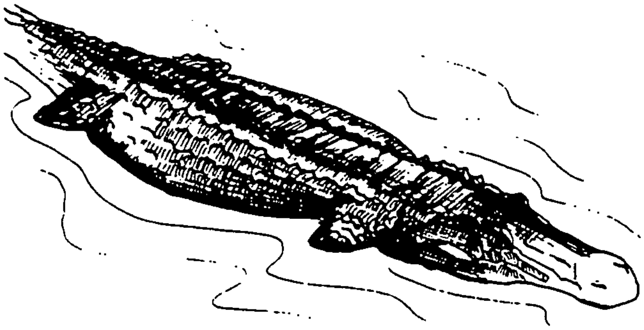
Cranefly Larva

Young Sea Otters



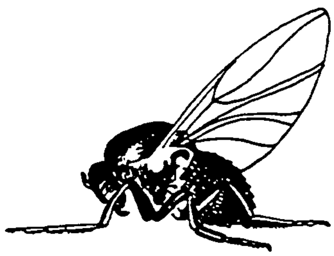
Sea Turtle Eggs

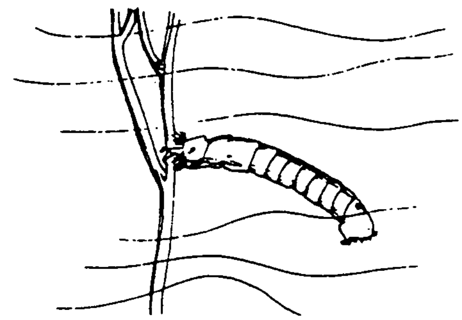
Alligator



Alligator Hatchlings

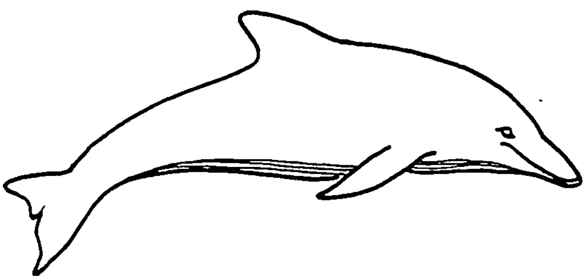
Black Fly

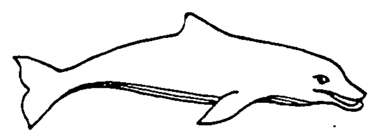




Black Fly Larva

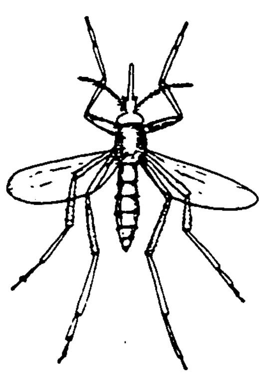
Porpoise

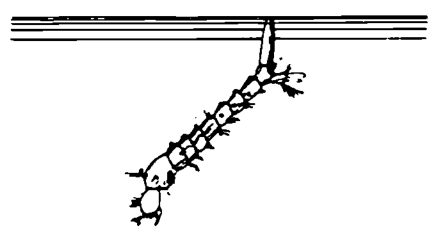




Young Porpoise

Mosquito





Mosquito Larva

Adult Beaver

Young Beavers

Water Wings

NONPOINT SOURCE POLLUTION AND BIOLOGICAL

Objective: Students will be able to identify water-related sounds and their sources at a stream. Students will also explore their own thoughts and feelings about aquatic environments through visualization and creative writing.

Location: Indoors

Time Frame: 20-minute listening and 20-minute art session

Subjects: Art, Language Arts, Music

Level: K - 2nd grade

Background:

A stream provides a habitat for many plants and animals. In addition, streams provide a source of beauty and recreation for people. All forms of life depend upon water, oxygen, nutrients and/or sunlight in some combination. Organisms are affected by and interact with the aquatic environment.

Unfortunately, the water in streams can be easily contaminated with agricultural runoff, sediment from erosion, and chemicals from industrial plants and our homes. Care must be taken to protect the quality of the water. Being aware of the many purposes of water helps us realize its usefulness and the need to be protected from pollution. Additional information is provided in Appendix B-2.

Materials:

Tape recording of water sound or of an aquatic habitat such as a river, lake, stream, swamp, or marsh. (You can find these tapes at local bookstores or make your own at a stream). The Georgia Wildlife Federation sells a "Natural Sounds of Georgia" tape.

Water-based paints (or poster paints), brushes, paper, containers for water

Pictures of water pollution (Garbage dumps at steams, paint or oil cans in water, etc.)

Objects that get thrown in streams (aluminum cans, plastic bottles, plastic bags, tires, clear cup of oil, clear cup of plant fertilizer, and a clear cup of mud)

Procedures:

1. Play the tape for the children. The first time, have them listen quietly and try to picture a setting for the sounds they hear. Have them concentrate on the quality of the sound, but ask them to not draw anything while the tape is playing.
2. Now play the tape a second time. This time, have the children say the names of things they hear as they listen, as you write them on the board.
3. Ask the children to close their eyes and try to recreate the picture in their minds

that was created by the sounds. What do they see? Tell them to imagine as much detail as possible, the colors, the plants and animals, the sky.

4. Now tell the children they will be painting a picture of the scene they have just been listening to. Provide the materials and ask them to include all of the things that they heard and saw when they closed their eyes.
5. Now show the children pictures and objects that pollute the water. Ask the children how the pollution changes their pictures. Ask the children if they can think of any other things that damage streams and rivers. How would the tape of a polluted stream sound?
6. Have the students display their artwork on their desks or on a bulletin board.

Questions:

1. What type of sound comes from a clean stream?
2. Draw three sources of pollution in our streams?
3. How would the sounds differ for a clean and polluted stream?
4. What can adults and kids do to keep streams clean? (Answers may vary.)

Extension:

1. Take a short field trip around a local stream, pond, lake, or river when human-made sound will be at a minimum. Have the students record the sounds they hear. Later in the classroom, play the sounds the students recorded during other activities.

Remember:

It is vital to know the condition of the stream before sampling. Animal waste, agricultural runoff (pesticides, herbicides, etc.), industrial wastes, or sewage leaks can be hazardous to you and your students. If you find a stream with any of the above contaminants, a class should not collect samples in the stream or use proper precautions. Students should wear protective boots, gloves, and goggles when necessary or when stream conditions are unknown. In case of serious water quality problems, notify local or state authorities.

Taken from Always a River, "Water Wings".

Little Sprouts

BIOLOGICAL

Objectives: Students will determine how water quality affects plant growth.
Location: Indoors
Time Frame: 3 weeks. Initial class of 30-40 minutes.
Subjects: Science, Math
Level: K-5th grade

Background:

Water is essential for life. Most seeds will begin to germinate when soaked in water. However, the quality of water can affect plant growth. In some sections of the country, the salt content in the soil is very high and affects the plant life in the area. Soap and detergents may represent pollutants such as nutrient run-off. Many detergents contain phosphorous, a nutrient in small amounts but a pollutant in large amounts. The vinegar represents acids that could result from acid rain, pesticides and other industrial chemicals. Vinegar is about 5% acetic acid and 95% water. In this exercise, salt, soap, and vinegar will be added to water to represent potential contaminants and environmental conditions. For more detailed information about non-point source pollution, see Appendix B-1.

Materials:

1 sandwich size baggie (for each student)
Paper towel
1 large bag with pre-soaked lima bean seeds
4 Two liter plastic soda bottles filled with different watering solutions as follows:

Solution 1- Tap Water
Solution 2- Salt water (1 cup salt/2 liter bottle)
Solution 3- Soap water (½ cup liquid soap/2 liter bottle) Check to see if your detergent is "phosphate free". If so, add a ½ tsp. plant fertilizer.
Solution 4- Vinegar (use vinegar at concentration)

Preparation:

1. Pre-soak approximately 150 large lima beans overnight (lima beans from the grocery store work well for this experiment).
2. Make a large bulletin board garden scene with 4 sections for each of the different solutions.

Procedures:

1. Discuss what a seed needs to sprout. (Light, air, water).
2. Ask students if they think seeds would grow if they were given water that was polluted with other substances such as salt, soap, and vinegar. Suggest that

they try each solution and see what happens.

3. Divide the class into groups of 4 and assign a different solution to each student in the group.
4. Pass out 1 baggie, 1 paper towel and 4 pre-soaked seeds to each student. Label each baggie with the student's name and solution.
5. Fold the paper towel in half and then in half again. Fold up the bottom edge of the quarter section to form a "pouch" to place the seeds on and staple it in place.
6. Poke a small hole thorough the paper towel "pouch" below each seed. The roots will be able to grow down through the hole to reach the water solution in the bottom of the baggie.
7. Insert the paper towel and seeds into the baggie and staple it to the baggie. Make sure part of the paper towel hangs down into the water solution so that the paper towel will be kept moist to hasten germination.
8. Pre-mix each watering solution in 2 liter soda bottles for easy access by the students.
9. Have each student pour about 70 ml of their solution into their baggie, moistening the paper towel and the seeds completely.
10. Each baggie may be stapled to a garden scene on the bulletin board or taped to a sunny window.
11. K-2: Have the students draw a picture of their seed's growth on their activity sheets. 3rd-5th: Count the number of seeds that germinate and measure height. Have 3rd-5th students make a bar graph.

Questions:

1. Did all the seeds start to grow?
2. Which seeds grew at the beginning of the experiment? at the end?
3. What did the seeds look like when they stopped growing?
4. Why do you think they stopped growing?
5. Which liquid would you choose to water your seeds?

Extension:

1. Experiment with other types of seeds by following the same procedures.
2. Transplant seeds into larger pots at the end of the last observation.

Taken from the Activities Integrating Mathematics and Science, Water precious Water, "Little Sprouts".

Little Sprouts ACTIVITY SHEET

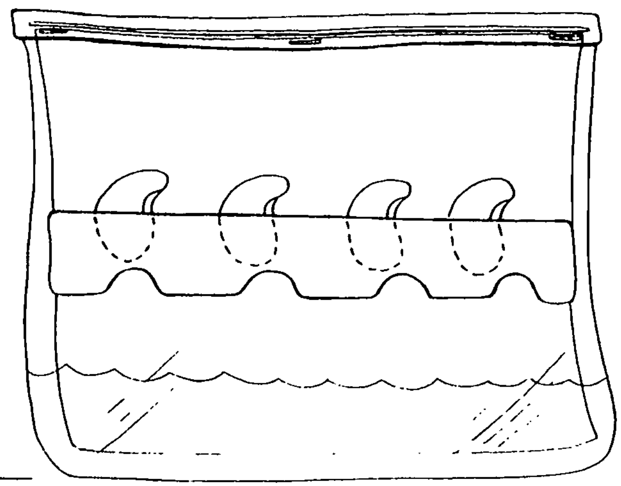
Treatment	**Picture**
Water	
Water plus salt	
Water plus soap	
Water plus vinegar	

Treatment	**Number Germinated (out of 4)**	**Height (average)**
Water		
Water plus salt		
Water plus soap		
Water plus vinegar		

LITTLE SPROUTS

Name ____________________

I am watering my seeds with ____________________



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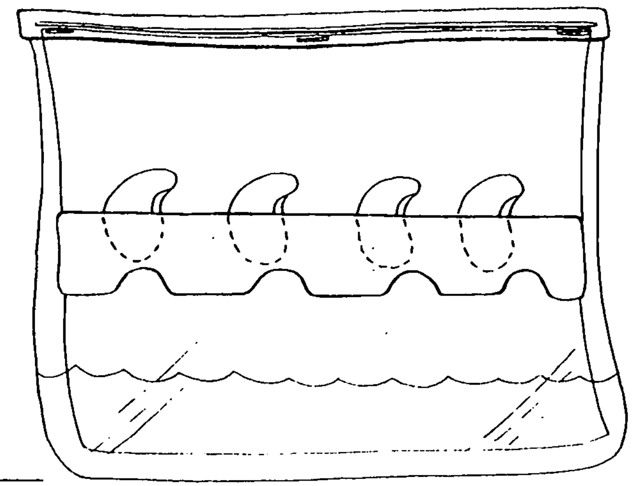

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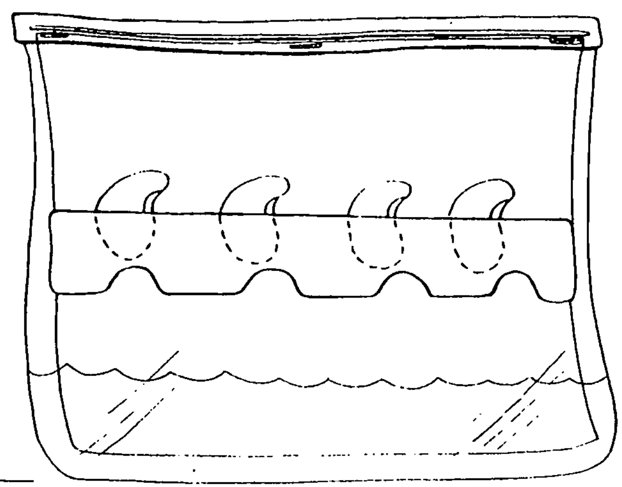

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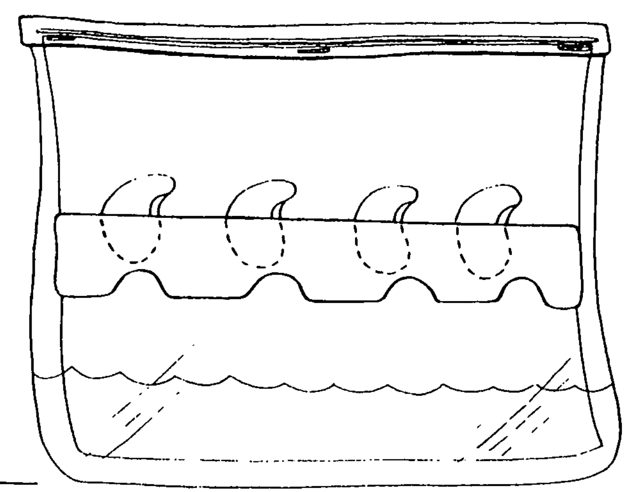


Day ___

Picture Perfect

Objective: Students will identify different types of water pollution and describe the differences between non-point and point pollution.
Location: Indoors
Time Frame: 60 minutes
Subjects: Science
Level: 5th - 8th grade

Background:

Water pollution is generally defined as any human-caused contamination of water that reduces its usefulness to humans and other organisms in nature. There are two broad classes of water pollution. One is point source pollution. It has its source in a well-defined location, such as the pipe through which factory discharge enters a stream. The other is non-point source pollution. It has its source over large areas such as farms, grazing lands, logging roads, construction sites, abandoned mines, and the gardens, lawns, streets, and parking lots of cities. Non-point source pollution is more difficult to control than point source pollution because it is so wide spread.

Other than sediment, the pollutants of greatest concern from rural and urban areas are plant nutrients, mainly nitrates and phosphates. Non-point sources of nutrients include inorganic fertilizers and animal wastes from agricultural operations, runoff from urban gardens and lawns, and septic tank failures. Excessive nutrients can cause unsightly growths of algae and aquatic weeds which adversely impact the entire aquatic ecosystem. Excess nutrients in the water increase algal and plant growth. These plants produce oxygen due to photosynthesis. If the stream has continual days without sunlight, these plants and algal blooms respire taking available oxygen out of the water. Thus, plants and algae deplete the supply of oxygen available to fish, and may cause fish kills. Fish kills occur when dissolved oxygen levels drop below levels required by the fish. (See Appendices A-2, B-1 and B-2).

Materials:

Handout attached.

Preparation:

Make copies of handout for students or other pictures of a stream with potential sources of non-point source pollution.

Procedures:

1. Introduce the terms water pollution, point, and non-point pollution. Discuss how different land uses might affect the quality of streams, lakes, and rivers. (See

Appendix A-2.)

2. Group the students. Have each group find all the possible sources of pollution on the handout provided. Explain to the students that many of the non-point source pollutants cause a problem only when it is raining. The students can list the possible sources or present the findings to the class.
3. To help the students, you may want to explain each type of pollutant after the students find the sources of pollution on the handout. The following may be on the poster:

-Runoff from streets causes oil, gas, and/or brake dust to flow into the stream.
-Unregulated smoke released from factories and cars causes air pollution.
-Banks without vegetation can erode, causing sediment to run into the water.
-Excess fertilizers added to cropland may runoff into streams and cause an increase of nutrients in the water.
-Cows releasing organic materials (wastes) into a stream causes an increase of nutrients in the stream and lowers the oxygen due to the breakdown of waste. In addition cows increase erosion when they walk in the stream.

Other possible pollutants:
-Septic tanks may leak and release wastes into the water.
-Leaking underground storage tanks at gas stations release gas and oil into the soil which will reach the stream.
-Construction may leave soil bare increasing erosion and sediment going into the river.
-Garbage is a hazard to fish.
-Improper forestry practices can cause erosion and increase temperature in the stream by removing sources of shade. Also, deforestation decreases the rainwater's ability to be absorbed into the ground.
See **Appendices A-2, B-1, and B-2** for additional information.

NOTE: It is important for students to realize the damaging levels of certain impacts vary. For example, small areas of erosion on a bank have less impact on a stream than a dozen cows walking through the stream. Also, certain practices minimize the impacts on a stream. When timber is cut, a buffer zone (area of uncut timber) can be left next to a stream to prevent erosion and shade the stream.

4. Review the different industries and potential sources of non-point source pollution in your community that may affect the stream.
5. Discuss possible solutions to the problems on the handout. See Appendix B-2 for additional information.

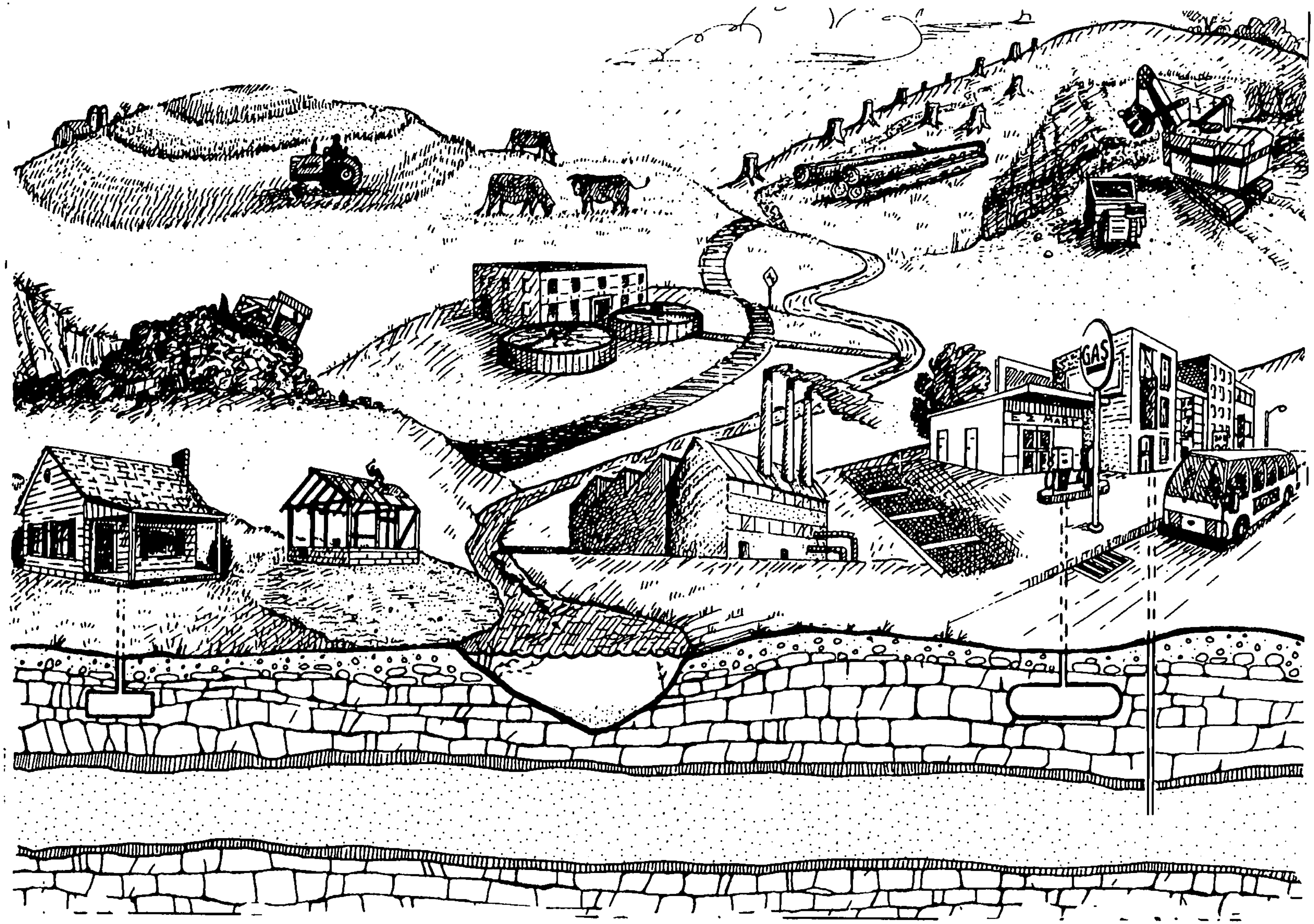
Questions:

1. List five types of non-point source pollution.

Extension:

1. Contact the Department of Natural Resources and ask for the "Mountain Stream" "Lake Ecosystem" poster for the class. You can call the local DNR office or (404) 918-6418 to obtain a poster. Compare posters to the handout or a local stream. Note activities available on the back.
2. Have the students make "stream awareness" posters and place them throughout the school.

Illustrations from Environmental Resource Guide, "Water Pollution Detectives".


GAS

Pollution Solutions

NONPOINT SOURCE POLLUTION

Objectives:	Students will be able to identify practices that contribute to non-point source pollution.
Location:	Indoors
Time Frame:	30-45 minutes
Subjects:	Science, Ecology, Geography
Levels:	3rd - 8th grades

Background:

Pollution sources are divided into two groups, depending on how the pollution enters a body of water. Point-source pollution is waste that comes from a specific point. Factories and wastewater treatment plants may have discharge pipes that lead directly to a waterway. These are considered point sources because they are easily identified as coming from one site.

Non-point source pollution comes from more than one specific location. It results from the runoff of water (rainfall, snowmelt, etc.) over land. As this water passes over the ground, it picks up pollutants and carries them into local streams and rivers. Non-point source pollution can also result from airborne pollutants that are deposited in waterways.

Non-point sources can be either rural or urban. Non-point source pollution in rural areas usually results from such things as poor agricultural or forestry practices. Urban non-point source pollution is caused by the run-off from city and suburban areas, such as oil, gas, and fertilizers from lawns. Additional information is provided in Appendices A-2, B-1, and B-2.

Materials:

1 Die from another board game
Playing board (See attached. Included is a copy of the board. Please copy the board and color for the students to use for the activity)
Cards (Included. Copy a set of cards for each group)
Crayons or highlighters
Cut square from different color construction paper
Optional: Vials with aquatic insects

Preparation:

Copy the playing board for each group (~5 boards). Have the students put together and color the boards as follows:

To put the board together, copy the four attached pages and have the students tape it together as follows:

#1	#3
#2	#4

The board has spaces with proper and improper water quality practices. Have the students color or highlight the spaces which are negative with red, positive with green, and neutral with blue.

Copy the "Card Page" and "Card Page Answers" (specific for the grade) onto the front and back of a piece of paper. Have each group cut out a set for their game.

Procedures:

1. Divide the class into groups of five. Have each student cut out construction paper in a square to represent a player. Make sure each team member has a different colored square. Optional: You may wish to use small vials of different types of aquatic insects to represent each player. The aquatic insects can be collected by using the procedures given in the Adopt-A-Stream Biological Monitoring lesson plan.
2. Each player is to line up on the "starting line"
3. Roll the dice to see who will move first. (The highest number rolls first, and so on)
4. Have the students move the number of spaces rolled on the dice.
5. Each student is to follow the directions in the space. They may have to move up, back, or stay in the space.
6. If a student falls on the space marked "read card", they are to take the card on the top of the pile, follow directions and then return it to the bottom of the pile.
7. The game will continue until a student reaches the "finish".

Questions:

1. Give two examples of non-point source pollution.
2. What is Non-point source pollution?
3. List two things that indicate a healthy stream.
4. List two things that can harm a stream.

Extension:

1. Have the students make up additional cards for the game. Make sure that each question the student writes has an answer.
1. Have the students participate in a Watershed Walk. See activity "Watershed Walk" or "Stream Journey."

Cards...."Pollution Solutions"

1. Give two examples of Non-point source pollution. Move 2 spaces.	2. Name two animals that live in a stream. Move 1 space.
3. What does Non-point source pollution mean? Move 2 spaces.	4. How can cows damage a stream if they walk through it? Move 1 space.
5. Name two rivers in Georgia. Move 2 spaces.	5. Cutting trees next to a stream is harmful to aquatic organisms. (True/False) Move 1 space.
6. List two things that could harm a stream. Move 1 space.	7. List two things you can do to help a stream Move 1 space.
8. Name two activities for which a stream can be used. Move 1 space.	9. Name two things you can find in a healthy (clean) stream. Move 1 space.
10. If you find water that smells bad and looks very dirty, whom do you need to tell? Move 1 space.	11. How do you know when water is polluted? Move 1 space.
12. When oil and chemicals get in a stream, they end up downstream. (True/False) Move 1 space.	13. Non-point pollution can easily be seen in a stream. (True/False) Move 1 space.

Card Answers...."Pollution Solutions" Answers for 3rd-5th grades

1. Cows walking in streams, sediment (soil) in stream, parking lot run-off, cutting trees next to a stream, agricultural run-off, etc.	2. Fish, turtles, frogs, salamanders, aquatic insects, beavers, ducks, etc.
3. Non-point source pollution is contamination that originates over a broad area from a variety of causes. (Erosion, Agricultural run-off, parking lot runoff, etc.	4. Cows release organic materials into a stream (cause an increase of nutrients in the stream). Also, cows increase erosion by walking in stream.
5. Chattahoochee, Flint, Savannah, Oconee, Altamaha, Ogeechee, etc. Any local rivers can be used.	5. True- causes erosion and increase temperature in the stream by removing sources of shade.
6. Agricultural run-off, cows in the stream, sediment in the stream, increase in temperature, elevated pH level, low dissolved oxygen, etc.	7. Remove garbage in the stream, streambank restoration, help prevent erosion, check for aquatic insects in the stream and other animals living in the water.
8. Canoeing, fishing, kayaking, swimming, tubing, etc.	9. Aquatic insects, fish, frogs, etc. Any living animal will answer this question.
10. You need to contact or tell someone who can tell the proper people. (Water Quality, EPA, etc.)	11. Trash in the water, high level of nutrients in the water, cows walking in a stream, water smells bad, and it may look dark green with algae growing on the rocks.
12. True- Any added chemicals upstream will travel downstream.	13. True or False- Depending on the source of the pollution it may be seen. An increase in algae will leave a green color in the water or grow on the rocks (High nutrients).

Card Answers...."Pollution Solutions" Answers for 6th-8th grades

1. Erosion of stream banks (construction, improper forestry techniques), Cows walking in stream, parking lot run-off, agricultural run-off	2. Caddisfly larvae, mayfly larvae, largemouth bass, bluegill, salamanders, frogs, turtles, and aquatic plants
3. Non-point source pollution is contamination that originates over a broad area from a variety of causes. (Erosion, Agricultural run-off, parking lot runoff, etc.)	4. Cows release organic materials into a stream causing an increase of nutrients in the stream lowering the oxygen due to the breakdown of wastes. Also, increase erosion by walking in stream.
5. Chattahoochee, Flint, Savannah, Oconee, Altamaha, Ogeechee, etc. Any local rivers can be used.	5. True- causes erosion and increase temperature in the stream by removing sources of shade.
6. Agricultural run-off, cows in the stream, sediment in the stream, increase in temperature, elevated pH level, low dissolved oxygen, etc.	7. Remove garbage in the stream, streambank restoration, monitor a stream, etc.
8. Canoeing, fishing, kayaking, swimming, tubing, etc.	9. Caddisfly larvae, hellgrammite, mayfly larvae, trout (N. Ga streams), turtles, and frogs.
10. Call the local authorities- EPA, Water Quality, or someone who can contact the proper authorities.	11. High phosphates and nitrates, smells bad, packs of algae growing on rocks, rocks covered with sediment, and trash.
12. True- Any added chemicals upstream will travel downstream.	13. True or False- Depending on the source of the pollution it may be seen. An increase in algae will leave a green color in the water or grow on the rocks (High nutrients).

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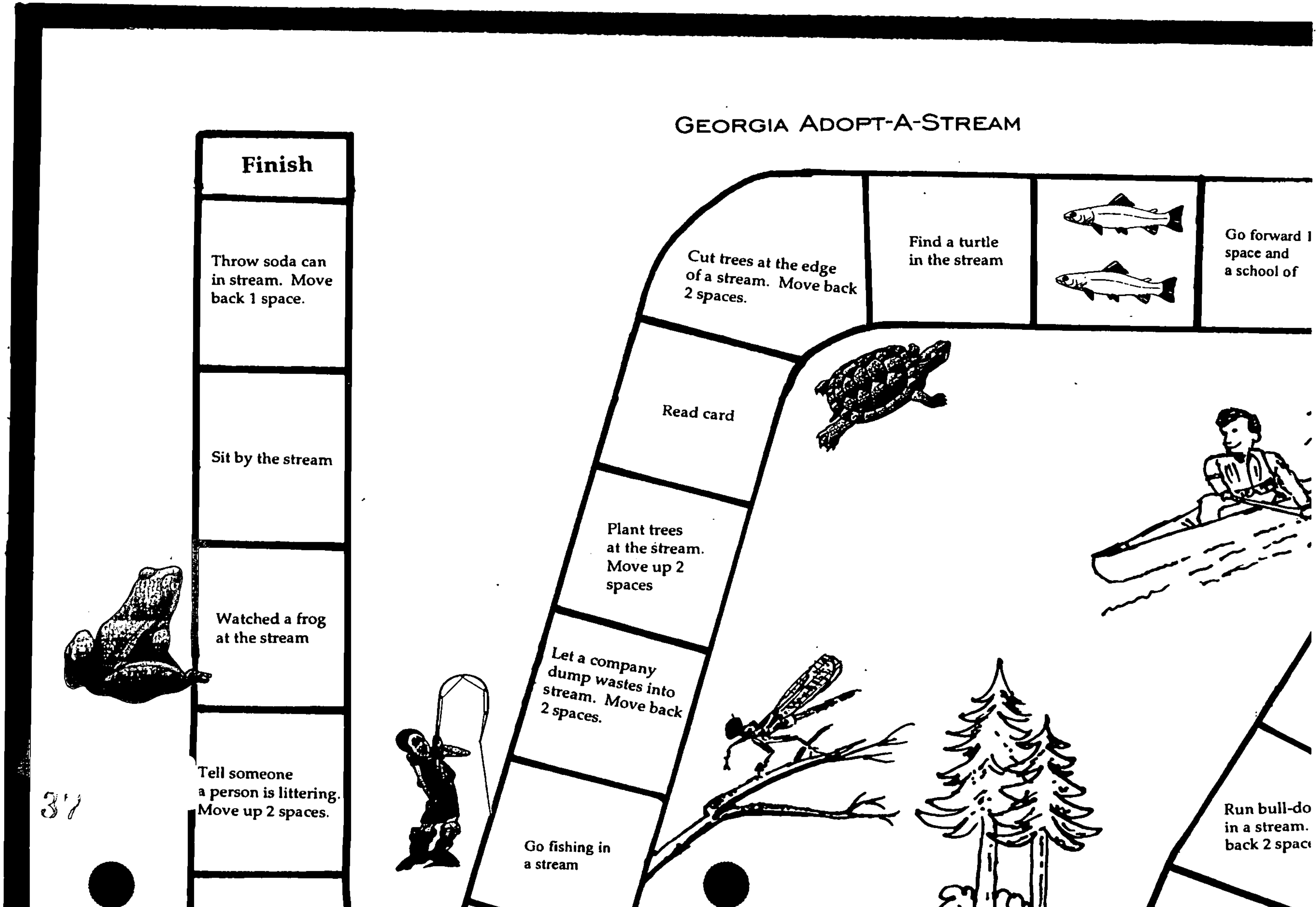
GEORGIA ADOPT-A-STREAM
Finish
Throw soda can in stream. Move back 1 space.
Sit by the stream
Watched a frog at the stream
Tell someone a person is littering. Move up 2 spaces.
Cut trees at the edge of a stream. Move back 2 spaces.
Find a turtle in the stream
Go forward 1 space and a school of
Read card
Plant trees at the stream. Move up 2 spaces
Let a company dump wastes into stream. Move back 2 spaces.
Go fishing in a stream
Run bull-do in a stream. back 2 spac

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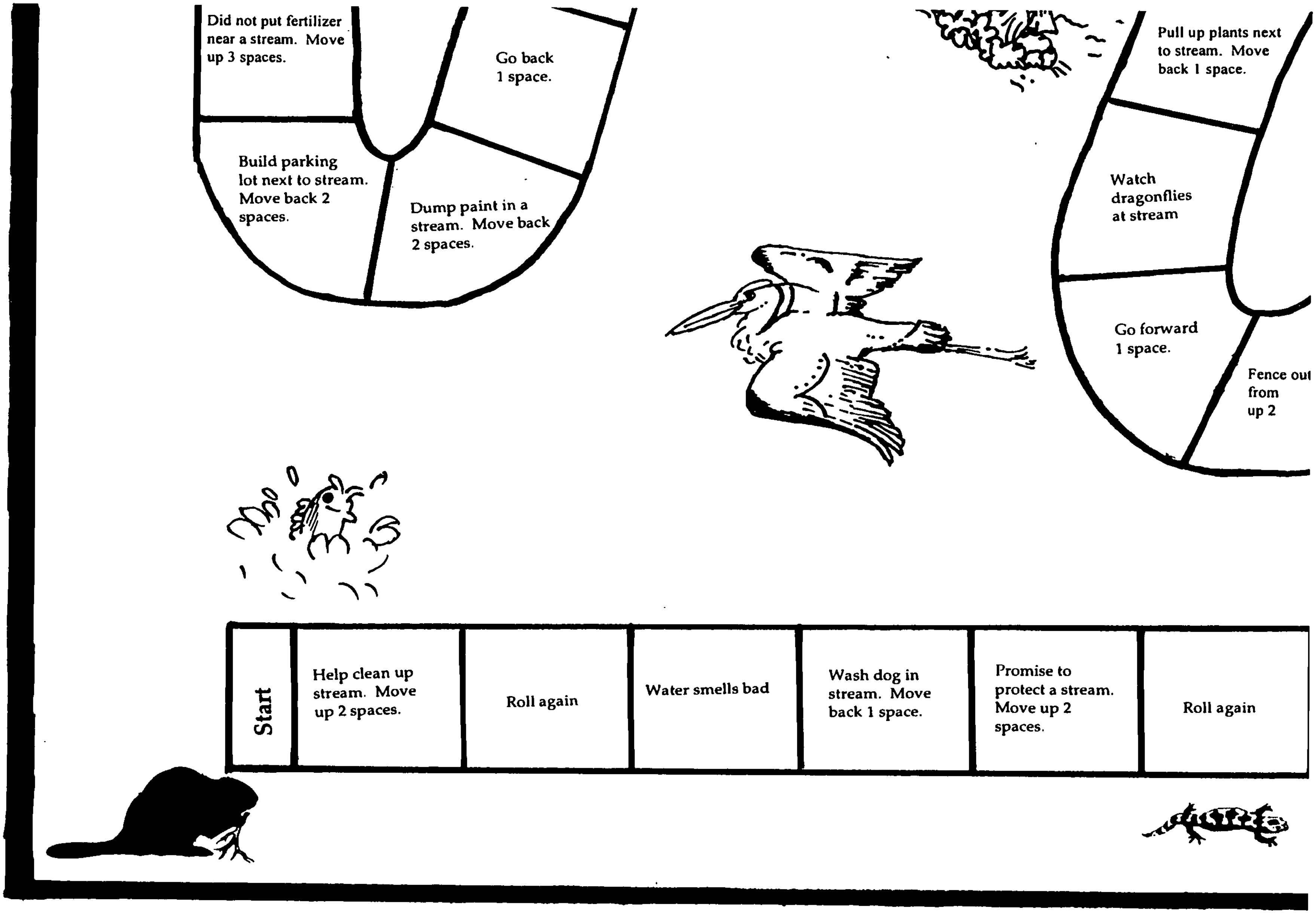
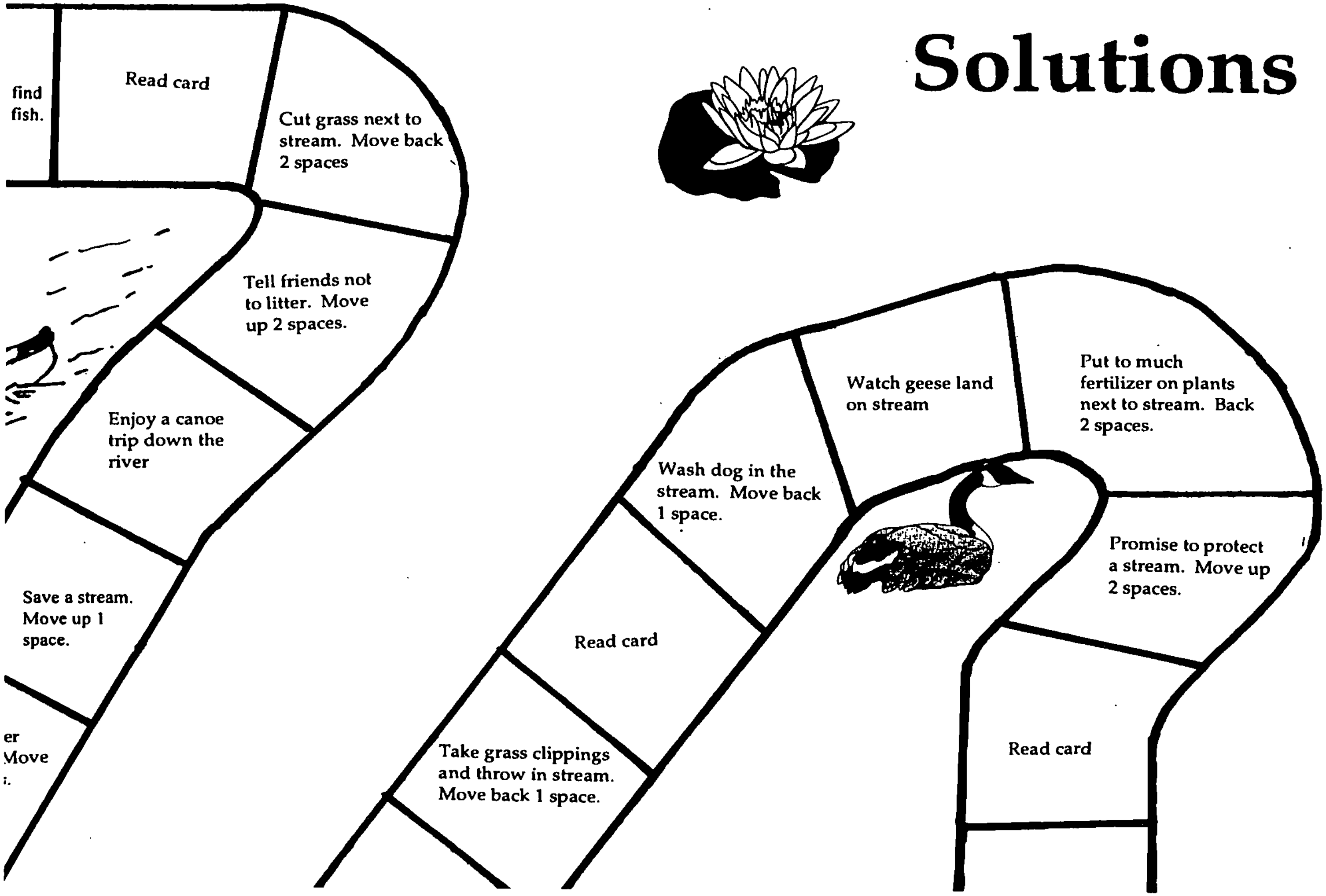
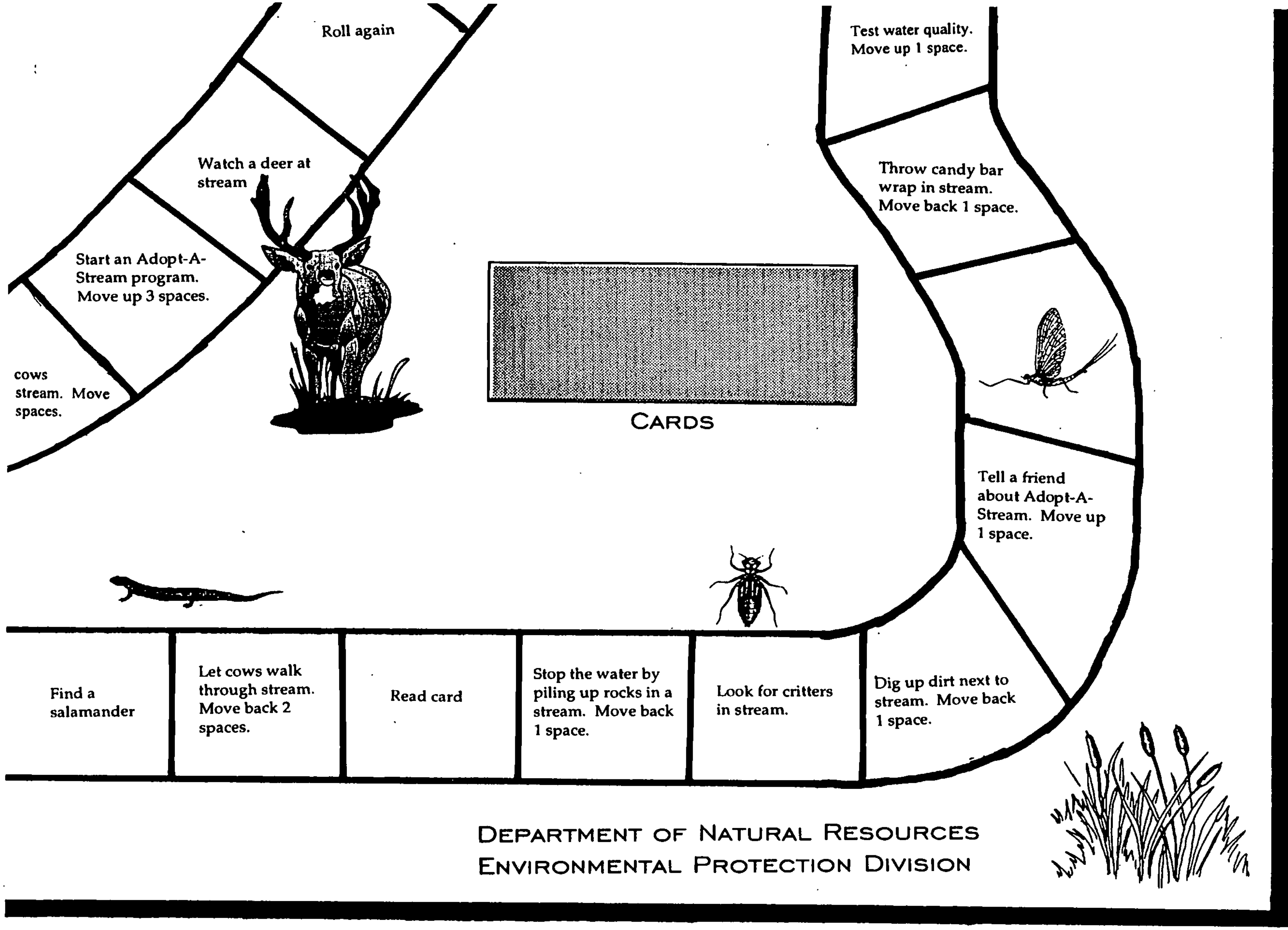

Did not put fertilizer near a stream. Move up 3 spaces.
Go back 1 space.
Build parking lot next to stream. Move back 2 spaces.
Dump paint in a stream. Move back 2 spaces.
Pull up plants next to stream. Move back 1 space.
Watch dragonflies at stream
Go forward 1 space.
Fence out from up 2
Start
Help clean up stream. Move up 2 spaces.
Roll again
Water smells bad
Wash dog in stream. Move back 1 space.
Promise to protect a stream. Move up 2 spaces.
Roll again

Pollution Solutions



#3

41 42



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#4

Adopt-A-Stream Detectives

BIOLOGICAL

Objectives: Students will conduct a biological monitoring project to determine the health of a stream.
Location: Outdoors
Time Frame: 2 - 60 minutes sessions
Subject: Science, Math
Level: 3rd - 5th grade

Background:

Water with a rich and varied range of aquatic creatures is usually a healthy environment, whereas water with just a few different species usually indicates conditions that are less desirable. Pollution generally reduces the quality of the environment and in turn the diversity of life forms. In some cases the actual biomass or amount of living material will increase due to pollution, but the diversity of species inevitably goes down.

Macroinvertebrates, such as burrowing dragonflies and damselflies, are found in streams. Scientists have learned that some species of macroinvertebrates are sensitive to pollution and will not be found in a polluted stream, whereas other species are more pollution tolerant. These species will be present in polluted and unpolluted streams, but will dominate in polluted streams. Additional information on aquatic insects is provided in appendices C-1 and C-4.

Materials:

Pencil and clipboard
white plastic dishwashing tubs
tweezers and forceps
hand lens
old tennis shoes or waders
rubber gloves
kick net or D-frame net:(See below)
Optional:
- Collection jars with rubbing alcohol (baby food jars work great!)
- "Stream Insects and Crustaceans"

Note: It is very important to realize the dangers in a stream. Before taking the students to the stream, check the site. Visit the stream to determine the easiest access. Also, check for any dangers, such as broken glass. Finally, it is a must to check how fast the water is flowing through the stream. Fast moving water is dangerous and students should not get into the stream, especially after a rainstorm. A good tip to remember is not to let the student get above their knees in the water. In addition, rocks can be

slippery, therefore; students should not stand on rocks or play around in the water. Having an assistant or parent work with the class is advised.

Preparation:
The students can go to the stream and collect the water samples or you may have them ready for the class. Teachers may want to attend an Adopt-A-Stream workshop on biological monitoring to practice sampling methods and learn macroinvertebrate identification.

Many of these lesson plans require a class to collect samples from nearby streams. It is vital to know the condition of the stream before sampling. Animal waste, agricultural runoff (pesticides, herbicides, etc.), industrial wastes, or sewage leaks can be hazardous to you and your students. If you find a stream with any of the above contaminants, a class should not collect samples in the stream or use proper precautions. Students should wear protective boots, gloves, and goggles when necessary or when stream conditions are unknown. In case of serious water quality problems, notify local or state authorities.

Procedures:
Part One:
1.Read "Some background on aquatic insects" (Appendix C-1).
2.Make a kick seine (See appendix C-5), purchase a D-frame net or borrow from a local Adopt-A-Stream group or Regional Training Center.

Part Two:
1. Find a sampling location in your stream. Macroinvertebrates can be found in many kinds of habitats--places like riffles (where shallow water flows quickly over rocks), packs of leaves, roots hanging into the water, old wood or logs, or the stream bed. If present, riffle areas will have the most macroinvertebrates. Sample these areas first, following step 2a. If your stream has a muddy bottom, follow step 2b.

<u>For streams with riffles:</u>
2a. Assign students to one of the jobs listed below. Collect macroinvertebrates in riffles with a kick seine. Look for an area where the water is 3 to 12 inches deep. Place the kick seine downstream and firmly wedge the seine into the streambed. Gently rub any loose debris off rocks and sticks so that you catch everything in the seine. When you have "washed off" all the rocks in a two foot by two foot area, kick the streambed with your feet. Push rocks around, shuffle your feet so that you really kick up the streambed. Now gently lift the seine, being careful not to loose any of the macroinvertebrates you have caught. Add two handfuls of old, black leaves to your sample. Take the seine to an area where you can look it over or wash the contents into a bucket. Repeat in two different riffle areas.

1. Net holders- Two individuals anchor the net to the bottom of the stream below a riffle. One individual can anchor the bottom of the net with rocks, so that nothing washes under the net.
2. Rock rubbers-Individuals rub rock surfaces to wash off any anchored critters attached to the rock. Rub all rocks in a 2 x 2 area.
3. Stream dancers-Students should begin kicking the bottom of the stream with a shuffling motion to disturb the first few inches of the stream bottom. Begin three feet upstream and move toward the net.
4. Net removers-Have the rock rubbers feel along the bottom of the net and gently remove any large stones holding down the net. As the rocks are removed, rub them quickly to wash off any critters that may be clinging to them. Have two students grab the bottom of the net and scoop it forward, making sure leaves, sticks and debris does not fall out.
5. Leaf lifters-Have two students each gather a handful of old, black clumps of leaves. Place in bucket.
6. Bug pickers-Carry the net to a flat area along the stream and spread it out. Immediately begin picking up anything that moves and placing it in pans of water. Pick up large organisms first so they do not crawl away. Look carefully on leaves, twigs, and gravel. Take the critters and place them into a tray or tub to look at.
7. Bug Detectives-Using a small magnifying box, have the students look at the bugs in water. Have the students count the number of bugs in each seine net.

<u>For muddy bottom streams:</u>
2b. If you sample a habitat other than a riffle area, use a D-frame (or dip) net to collect macroinvertebrates from these three habitats: steep banks/vegetated margins, silty bottom with organic matter, wood debris with organic matter, and sand/rock/gravel/substrate. In this method you will sample from three different habitats. Each sample involves a quick forward motion of one foot (a scoop). Collect several scoops from each habitat listed below. As you collect your samples, place the contents of the net into a bucket. Keep water in the pan to better see the organisms you have caught.

Steep banks/vegetated margins

This habitat is the area along the bank and the edge of the waterbody consisting of overhanging bank vegetation, plants living along the shoreline, and submerged root mats. Move the dip-net quickly in a bottom-to-surface motion, jabbing at the bank to loosen organisms. Each scoop of the net should cover one foot of submerged (under water) area.

Woody debris with organic matter

Woody debris consists of dead or living trees, roots, leaves and other submerged organic matter. It is a very important habitat in slow moving streams and rivers. The wood helps trap organic particles that serve as a food source for the organisms and provides shelter from predators, such as fish. To collect

woody debris, approach the area from downstream and hold the net under the section of wood you wish to sample, such as a submerged log. Rub the surface of the log for a total surface area of one square foot. Or put a large handful of dead leaves in your net.

Sand/rock/gravel/substrate

The streambottom can be sampled by moving the net forward (upstream) with a jabbing motion to dislodge the first few inches of gravel, sand, or rocks. You may want to gently wash the gravel in your screen bottom bucket and then discard gravel in the water.

Each time you sample you should sweep the mesh bottom of the D-Frame net back and forth through the water (not allowing water to run over the top of the net) to rinse fine silt and mud from the net. This will avoid a large amount of sediment and silt from collecting in the pan, which will cloud your sample.

3. Place macroinvertebrates in a white sorting pan or plastic sheet. Separate creatures that look similar into groups. Draw different types of insects found. Be sure to look at the number of tails, legs, size and shape of head and body.

Discussion:

Discuss which insects you found and if they would likely be found in a healthy or impacted stream. Make sure to tell the students the diversity (number of different kinds of insects) helps determine the health of a stream.

Questions:

1. Describe and name three aquatic insects that might be present in a stream. Consult the "Stream Insects and Crustaceans" sheet found in appendix C-2.
2. Why do you sample a stream?
3. Where did you find insects and other animals in the stream? What is the term for their "home"? (answer-habitat)

Extensions:

1. Begin a regular monitoring program to determine the health of the stream. Determine how the aquatic insects may vary depending on the season.
2. Have the students identify the bugs according to the "Aquatic Insect Guide" in Appendix C-2. Enlarge pictures of the aquatic insects and their names. Have students match names and pictures.

Based on Izaak Walton League of America, Save our Streams, "Stream Doctors" and the Georgia Adopt-A-Stream program.

Pondering pH

CHEMICAL

Objective: Students will determine the pH of various substances, differentiate between acidic and basic substances, and make generalizations about the effect of pH on the aquatic environment.
Location: Indoors and Outdoors (Optional)
Time Frame: 60 minutes
Subjects: Science
Level: 3rd - 5th grade

Background:
pH - a measure of the concentration of hydrogen ions in a solution.

Different levels of acidity and alkalinity of water solutions are expressed in terms of pH. The pH scale ranges from 0 to 14, with each whole number decrease in pH representing a tenfold increase in acidity. A substance greater than 7 is a base, and one with a pH below 7 is an acid, but a pH of 7 is neutral.

Pure water has a pH of 7; however, the pH of water depends upon the environment that it passes over since water can dissolve substances that can change its pH.

The pH of water plays an important part in the distribution of plants and animals in the environment. Most fish can tolerate pH values of about 5.0 to 9.0, but fish eggs are more sensitive to the pH. In addition, the pH of the water may cause other reactions with chemicals and metals added to the water. Ranges for pH are discussed in Appendix D-1.

Materials:
- Distilled water (tap water or spring water may be substituted)
- White vinegar
- Baking soda
- Water samples from a nearby stream (or two samples, one upstream and one downstream of a land area that may impact the stream)
- Measuring cups (½ and 1/4 cup) and teaspoons (½ tsp.)
- pH paper, pH meter or universal indicators found in water quality test kits and pH chart (can be ordered from a supply company or ask a high school chemistry teacher)
- 4 small clear cups
- 3 stirring spoons
- Notebook
- pH scale (included)

Preparation:
Have small groups of students set-up with the following in small cups: water, vinegar,

baking soda, and stream water samples.

Optional: The class can take a visit to a nearby stream to collect the stream samples.

It is vital to know the condition of the stream before sampling. Animal waste, agricultural runoff (pesticides, herbicides, etc.), industrial wastes, or sewage leaks can be hazardous to you and your students. If you find a stream with any of the above contaminants, a class should not collect samples in the stream or use proper precautions. Students should wear protective boots, gloves, and goggles when necessary or when stream conditions are unknown. In case of serious water quality problems, notify local or state authorities.

Procedures:

1. Explain to the students that they will be measuring the pH of various solutions using pH paper, meter or universal indicator solution.
2. Divide the students up into groups of three or four. Give each group four to five cups, three spoons, and pH paper. Ask each student to label one cup "vinegar", one cup "baking soda", one cup "tap or distilled" water, and one cup "stream" water.
3. With the cups of baking soda, vinegar, distilled water and stream water already at the workstation, have each group mix the following into individual cups:

Vinegar:	½ c. Tap water + ½ tsp vinegar
Baking soda:	½ c. Tap water+ ½ tsp of baking soda
Distilled Water:	½ c. Tap water
Stream Water:	½ c. Stream water

4. At the workstation, have each group dip an unused, clean strip of pH paper in the vinegar cup for 2 seconds and immediately compare it with the color chart. Write down the value of the following worksheet. Is the vinegar an acid or a base?
5. Follow procedure four for the baking soda cup, stream water cup, and the tap water cup.

Note: In some cases, distilled water may register as an acid because carbon dioxide is present in the water.

Discussion:

1. What kinds of substances could enter the water to change its pH? (Consider some of the items the class tested and discuss pollutants and fertilizers. See Appendix B-1) Where would these substances come from (Urban, industry, agriculture)? Is there anything people could do to make the pH of water

neutral? (Neutral is when the pH is 7. Buffers can neutralize a solution.)

2. Discuss how the pH of water could affect the plant and animal life that live in a stream (Some aquatic organisms cannot survive in very acidic waters. See the attached pH values and effects.)

Questions:

1. What is the difference between an acid and a base?
2. Name two substances that are bases.
3. Name two substances that are acids.

Extension:

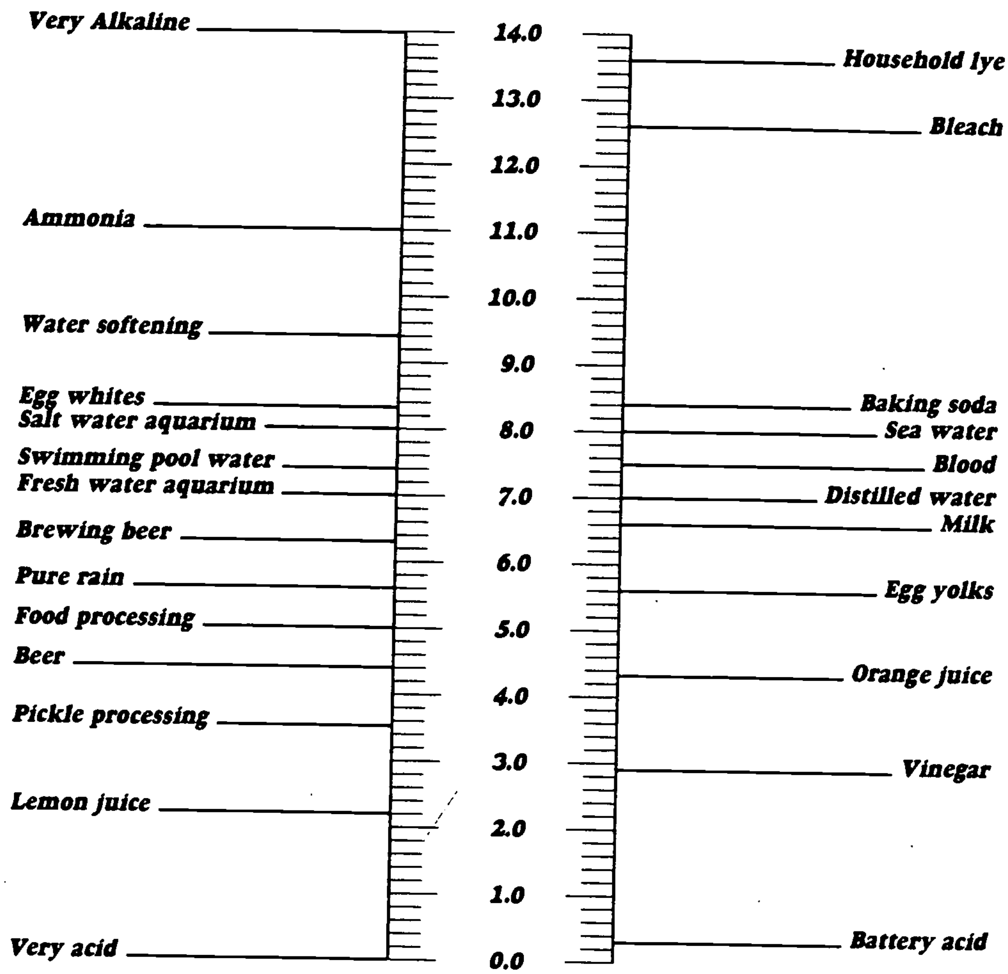
1. Ask the students to guess whether some common household products are acidic or basic. Examples include lemon juice, tomatoes, milk, shampoo, ammonia, coffee, soap solutions, and oven cleaners.
   Have the above solutions available for the students test pH. Discuss the different characteristics of a base verses an acid. (For example, bases are slippery and sour. Acids burn the skin.)
2. Make your own indicator. Red cabbage contains a chemical that turns from its natural deep purple color to pink in acids and blue/green in bases. Boil the cabbage in a covered pan for 30 minutes (or microwave for 10 minutes). Let the cabbage cool and then remove it. Pour 1/4 c. of cabbage juice into two clear cups. Add ½ tsp of baking soda to one cup and ½ tsp of vinegar to the other cup. Stir each cup with a spoon and observe the color changes that take place.
   Pour the contents of the vinegar cup into the baking soda cup. Does the color change? What does this tell you about the solution? (It has become neutral).

Based on Always A River, "Pondering pH".

Student Data Sheet:

Materials:	pH Value	Is it an acid or a base?
Vinegar		
Baking Soda		
Tap Water		
Stream Water #1		
Stream Water #2		

1. Are the following an acid or a base?
   A. Shampoo
   B. Milk
   C. Soap
   D. Lemon juice


Very Alkaline
Ammonia
Water softening
Egg whites
Salt water aquarium
Swimming pool water
Fresh water aquarium
Brewing beer
Pure rain
Food processing
Beer
Pickle processing
Lemon juice
Very acid
14.0
13.0
12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
Household lye
Bleach
Baking soda
Sea water
Blood
Distilled water
Milk
Egg yolks
Orange juice
Vinegar
Battery acid

How BIG is the River - Really?

WATERSHED

Objective:	Students will understand the concept of a watershed, identify a river's watershed system, and describe the immediate watershed in which they live.
Location:	Indoors
Time Frame:	60 minutes
Subjects:	Geography, Science, Social Studies
Levels:	6th - 12th grades

Background:

Watershed - Land area from which water drains to a particular water body.

As streams increase in flow and join with other streams, a branching network is established, much like the branches of a tree. This network is called a river system.

A watershed is all the land area that contributes runoff to a particular body of water. It is a catch basin that guides all the precipitation and runoff into a specific river system. What affects a watershed in one place eventually affects other sites downstream. Damage often accumulates as water proceeds downstream.

A topographic map can be used to determine the contours of a watershed, identify some land use practices, and plan best management programs to prevent or reduce pollution. To effectively use topographic maps, it is necessary to understand the information depicted.

Topographic maps show the shape of the earth's surface using contour lines. Contours are imaginary lines that trace the land's surface at a particular elevation. Elevation is important in analyzing water flow patterns. Because water flows downhill and perpendicular to contours, a watershed can be determined from a topographical map. Intervals between contour lines are indicated on the map scale. A typical interval is 20 feet or 20 meters. Concentric circles, ovals or ellipses indicate a knob or hill. By marking the hilltops and ridges, it's possible to create a good outline of the complete watershed. Appendix A-1 gives instructions for mapping out a watershed.

Materials:

-Copies of a topographical map (scale 1:100,000) of the river watershed nearest the school. There needs to be a map for every group in the class.
-A large map of Georgia (scale 1:24,000) showing the rivers and tributaries
-To order maps call the Geological Survey, Environmental Protection Division - 404-656-3214.
-Transparency pens
-Acetate sheet and tape (plastic) - only needed if the maps are not laminated.

Preparation:

Before giving out the maps, have the Georgia and topographical maps laminated so they can be used again. Be able to map out a watershed before helping the students. Clear instructions are provided in Appendix A-1.

Procedures:

Part one: Mapping the Watershed (Grades 6th - 12)

1. Discuss the following terms: watersheds, contour lines, elevation, runoff and non-point source pollution. Definitions and explanations are given in Appendices A-1, A-2, and B-1.
2. Divide the class into groups of 3 or 4. Give each group a Georgia map showing the rivers and tributaries and the "Major Watersheds of Georgia" (located in Appendix A-3).
3 Have students find their own town or community on the maps.
4. Have students locate the main river closest to the school on the Georgia map (scale 1:24,000) and trace over it with a marker or crayon.
5. Have the students locate the rivers that join to form the main river and trace over them with a different color marker or crayon.
6. Give each group a topographical map. If the maps are not laminated, give each group an acetate sheet to tape to the map.
7. Have the students outline the watershed next to the school. The students should first locate the high points (hilltops) in the areas then draw the watershed following the contours. Follow the directions and examples given in Appendix A-1.
8. Ask students to tell the direction the water is flowing and how they know. *Make sure to mark any lakes that are a result of a dam. If a dam is present, discuss the advantages and disadvantages.
9. Have students determine where the river nearest to you goes. Rivers in Georgia flow to the Atlantic Ocean or the Gulf of Mexico.

Part two: (Grades 9th - 12th) - Estimating the size of the Watershed

Materials: Dot grid (provided)

1. Copy the dot grid and provide each group with a copy.
2. Have the students take the acetate sheet off the topographic map and place it onto the dot grid.
3. Count all of the dots that are fully within the watershed boundary plus every other dot that falls on the line around the area. Record the number of dots. Repeat this procedure three times, randomly placing the dot gird each time. Take the average number of dots from the three counts and multiply by the appropriate acres/dot factor on the bottom of the dot grid. This will be the estimate of the size of the watershed in acres.

Optional: Calculate the amount of rain that falls on the watershed by finding out the average rainfall and multiplying the value by the watershed area. It may be more appropriate if the amount of rain is converted to gallons. (Contact the local Soil Conservation Service for rainfall data.)

Discussion:

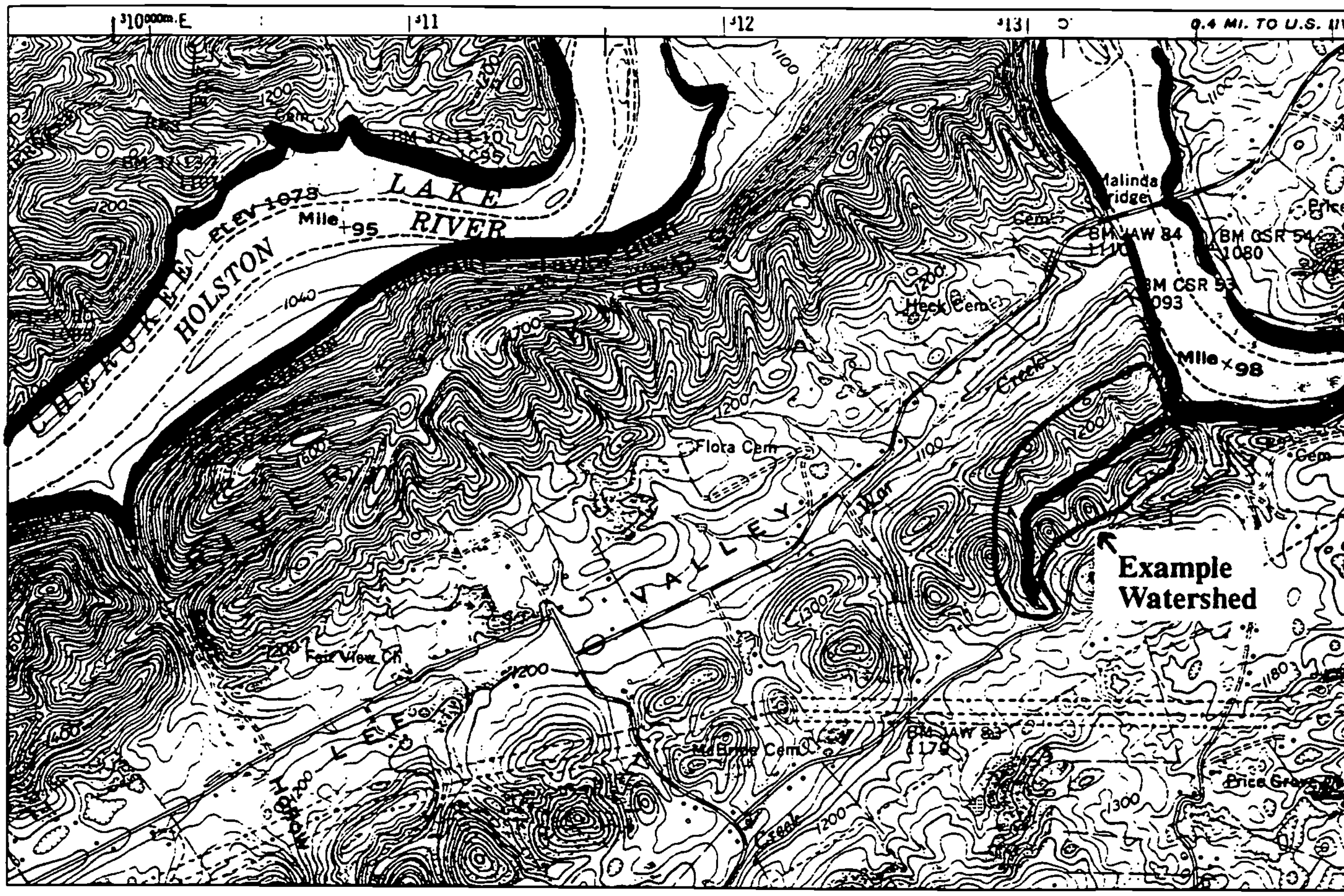
1. What is a watershed?
2. What is runoff and where does it come from?
3. Knowing the size of the watershed, how do you think the land uses in the watershed affect water quality? (Answers can be found in Appendix A-2).
4. Discuss the different land uses that exist in the watershed the students mapped out. (Examples may include farms, crop land, forests, parking lots, etc.)
5. Propose solutions to any existing problems in the watershed.

Questions:

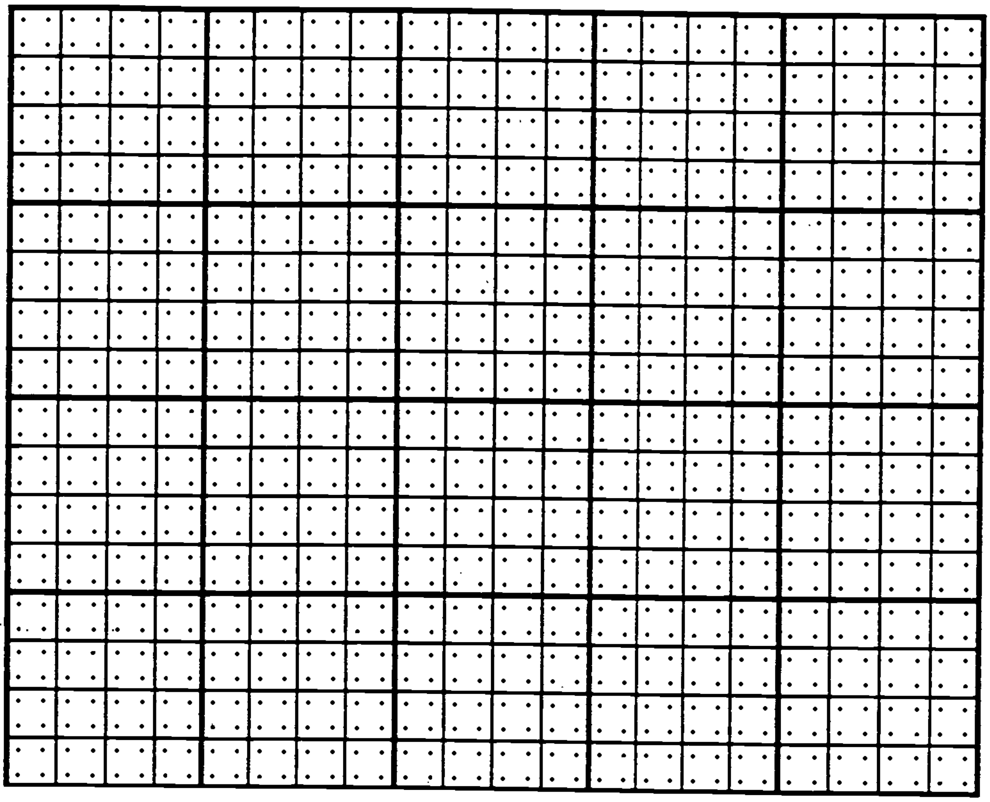
1. What is runoff? What land uses may influence the quality of runoff? (roads, parking lots, farms and lawns). Possible answers in Appendix A-2.
2. How might this affect the water in the watershed's streams ? (fertilizers, pesticides, silt, and other pollutants could run into the streams)
3. How is the volume and rate of runoff affected by the land use in the watershed? (More impervious surface in watershed increases both.)
4. Will the conditions of the runoff in your watershed affect others downstream?
5. Where does all of the water eventually go? (Gulf of Mexico or Atlantic Ocean)

Based on the Tennessee Valley Authority - Fall Workshop Teacher Guide, "Interpreting a Topographic Map."

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY



DOT GRID MASTER



Map Scales and Equivalents

Fractional Scale	Acres per Square Inch	Acres per Dot
1: 24,000 (1 inch = 2,000 ft.)	91.8	1.43
1: 100,000 (1 inch = 8,333 ft.)	1594.0	24.9

1. Clearly draw line around area to be estimated.
2. Place dot grid randomly over area to be estimated.
3. Count all dots fully within the area plus every other dot that falls on the line around the area.
4. Record total number of dots.
5. Repeat three times, randomly placing grid each time.
6. Take average of dot counts.
7. Multiply by appropriate acres/dot factor.

NOTE: Areas larger than dot grid may be estimated by breaking down into smaller areas, then totalling dots.

How Much Water Falls Here?

WATERSHED

Objective: The students will calculate the volume of water that falls onto an area of the school parking lot. Older students will compare this volume to common water-consuming activities.
Location: Indoors/Outdoors
Time Frame: 90 minutes (can be divided into two class sessions)
Subjects: General Science, Ecology, Physical Science, Biology, Chemistry, Physics, Math
Levels: 6th - 12th grade

Background:

Pollutants can enter our water supply from a variety of sources. Runoff from large areas of pavement is particular likely to contain pollutants, since none of the water or pollutants can be absorbed through the pavement. Urban stormwater runoff may contain sediment, debris, oil, gasoline, and heavy metals (nonpoint source pollution).

Urbanization and other development may adversely affect stream health by increasing the volume of surface runoff while decreasing runoff times. When it rains in areas with lots of impervious surface (parking lots, roofs, roads), water runs off at a higher speed because it is not absorbed into the ground. Potential pollutants are transported more quickly from the land to the receiving water. This sometimes causes a phenomenon to occur called "shock loading". This can result in fish kills or algal blooms depending upon the type of pollutants in the runoff. Suspended materials in the runoff can also absorb and store heat which increases the water temperature. Changes in water temperature can also harm aquatic life. Areas with lots of vegetation absorb rainwater, slow runoff and filter pollutants.

Materials:

- Yardstick
- Tape measure
- Trundelwheel (optional)
- Clipboards (optional)
- Writing materials
- Protractors
- Graph paper
- Calculators
- Rulers
- Local rainfall data
- Long piece of twine (meter and foot intervals)

Preparation:

Call the local weather center or Soil Conservation Service in the county to find out the average annual rainfall for your area.

Procedures:

Explain to the students they are going to calculate the volume of runoff from the school parking lot. This volume flows to the nearest stream.

Part one: (Grades 6th - 12th) - Calculate the area of the school parking lot and volume of runoff.

1. Divide the class into teams of 3-5 students.
2. Draw a sketch of the parking lot on the board. Have each team select an area they wish to measure. If the lot has multiple sections, give each group a certain area to measure. Note: Make sure the students use the same measurements (feet or meters).
3. Have the students go outside and take needed measurements. Transfer measurements and any landmarks to sketch on board.
4. Have students draft a sketch of the parking lot with all measurements one on a regular piece of paper **(Grades 6th - 8th)** and/or to scale on graph paper **(Grades 9th - 12th)**.
5. Have each team determine the direction of runoff and distance to nearest stream Note: A map can be used to estimate a distance to the stream, if the stream is not next to the parking lot.
6. Have the students estimate the area of the parking lot. Have the students divide up the lot into shapes then calculate the parking lot area. For example:

   Square: Area=Length X Width
   Triangle: Area = ½ Base X Height

   The values should be in the units the students measured on the parking lot. Add together all the individual shapes' areas to find the total area of the parking lot.
7. Determine the volume of rain falling on the parking lot annually. Multiply the average annual rainfall (convert to feet or meters) by the area of the parking lot (square feet or meters). Volume should be recorded in cubic feet (ft^3) or cubic meters (m^3).

Part two: (Grades 9th - 12th) - Comparisons of runoff volume to everyday water usage.

The following conversions are useful:

1 ft^3 =	7.2827 gallons
1 m^3 =	1000 liters
5 minute shower =	25 gallons or 95 liters
Density of water =	1 gallon = 8.34 lbs.
	1 liter = 1 kg.

1. Have students calculate the following:

Average annual rainfall:	______________ inches
Convert rainfall from inches to feet	______________ ft (X 1ft/12in.)
Surface Area of Parking Lot	______________ ft^2
Volume of runoff	______________ ft^3
Convert volume of runoff to gallons	______________ gallons of runoff
Determine how many 5 min. showers can be taken with the amount of runoff	______________ showers
If you took a shower every day, how long would it take to shower this many times?	______________ years
Determine the weight of runoff in lbs.	______________ lbs.

2. Compare the student's estimates to see the variations in values. Make sure all students understand how final answers were derived.

Questions:

1. Where does the runoff from the parking lot go?
2. What route does the runoff take? (Stormdrain, drainage ditch, stream, culvert) Is the area from the parking lot to the nearest stream vegetated or paved? If both, estimate percentage of each.

Extension:

1. Predict how much erosion will occur at your school with a 30-minute rain. The following values can be obtained from the Soil Conservation Service in your county.

To calculate:

E= R X K X LS X C X P

E = Soil lost by erosion (tons/acre/yr)
R = Rainfall factor
K = Soil erodiabilty factor (tons/acre) (based on the soil type)

L.S. = Topographic factor (based on slope)
C = Cover and vegetation type

2. Place a rain gauge next to the school. During the next rain, record the rainfall duration and amount. Calculate the amount of rain in 30 minutes. Using the erosion calculation from above, determine the amount of erosion occurring as a result of the latest rainfall.

Based on the Environmental Resource Guide.

Dragonfly Pond

NONPOINT

Objective: Students will evaluate the effects of different land uses on wetland habitats and discuss lifestyle changes needed to minimize non-point source pollution.
Location: Indoors
Time Frame: 60 minutes
Subjects: Science, Social Studies
Level: 6th - 8th grade

Background:

Every human use of land affects wildlife habitat, positively or negatively. What humans do with land is a reflection of human priorities and lifestyles. The search for a modern day "good life" and all of its conveniences produces mixed results for wildlife and the natural environment. Sometimes people see undeveloped areas of the natural environment as little more than raw material for human use. Others believe that the natural environment is to be preserved without regard for human needs. Still others yearn for a balance between economic growth and a healthy and vigorous natural environment. Very real differences of opinion regarding balance exist between people.

At the core of land use issues is the concept of growth. Growth in natural systems has inherent limits. Continued survival for plants and animals is determined by food, water, shelter and space availability. Often, humans do not realize the impacts of their activities on the surrounding environment. Non-point source pollution is one negative impact humans may have on their local environment. Non-point source pollution harms streams. Further information on non-point source pollution is provided in Appendices B-1 and B-2.

Materials: Each group will need:

- Scissors
- Masking tape
- Paste or glue
- Paper
- One set of land use cutouts
- Large piece of paper which to fasten the cutouts.

Preparation:

Prepare copies of the two cutout sheets ahead of time.

Procedures:

1. Explain the activity by telling the students they will be responsible for arranging the pattern of land use around the "Dragonfly Pond" in such a way as to do the best they can to preserve the health of this beautiful area.

2. Divide the class into groups of three to five and give out the land use materials. Have the students cut out the land use pieces. Tell them **all** the land use pieces must be used on the pond area. The park and farm land may be cut into smaller pieces, but each piece must be used. Parts may touch, but not overlap. It is important to inform the students that the "bleach factory" must have access to the water for production and the "farm feed lot" is an area of little grass where cows are overcrowded and fed grain. Additional highways can be added. Note: Make sure they indicate which direction the water flows (from top to the bottom of the page).
3. Have the students arrange the parts on the paper. Once all the groups have agreed on the land use location, have the groups tape the pieces to the paper.
4. Begin a discussion with the possible pros and cons of each land use. The following are a few examples:

	PROS	CONS
Farm:	*produce food *economic value *provide jobs	*use pesticides that may run off into the water *soil erosion *use chemical fertilizers that may damage water supplies
Businesses:	*produce employment *provide commerce *economic stability	*produce wastes and sewage *contaminate water (detergents, etc.) *use chemical fertilizers
Homes:	*provides a sense of place *provides a community *provides shelter	*generate wastes and sewage *use water *loss of wildlife habitat

5. Have the groups reexamine the pond. Without changing the land use pieces, have each group decide if the pond best supports the :
   a. Residents
   b. Farmers
   c. Business
   d. Gas station owners
   e. Parks
   f. Highway
   g. Bleach factory
   h. Wildlife

6. Invite each group to volunteer to display and describe their "ponds". Look for the consequences of their proposed land use plan. Be firm about the issues, but fair about this plan.

Additional points should include the need for an economic base for the town. Also, farmlands provide habitat for some wildlife, but if the wetland has to be drained for the farmland a habitat will have been destroyed.
Make sure to point out the advantages to every plan. In addition, ask for any suggestions.

7. Water drains downstream, so all the wastes that go into "Dragonfly Pond" will affect the waters downstream. When all the students have finished proposing their plans, have each group tape their ponds to the board with the drainage from one group's plan to another. The streams should attach on every plan.
8. When each town plans its water use without considering downstream impacts, what happens? Have the students tell the possible consequences and possible solutions to the problem. For example, where will the water be treated? Where will the water go?
9. Ask the students to create a list of things they can do to begin to reduce the potentially damaging effects of their own lifestyles on the "downstream" habitats and protect water quality. Use DNR's Pointless Pollution brochure.

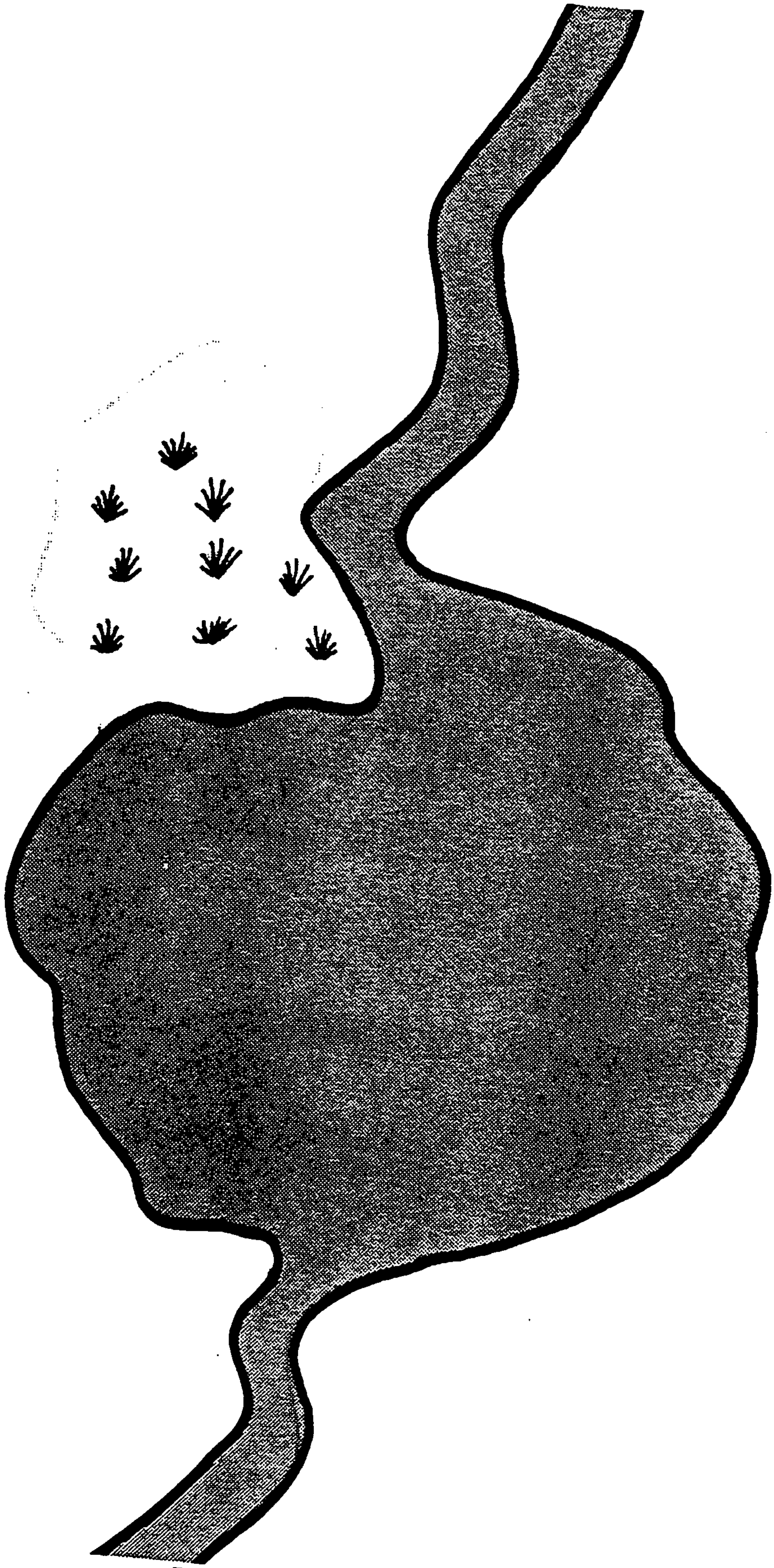
Questions:

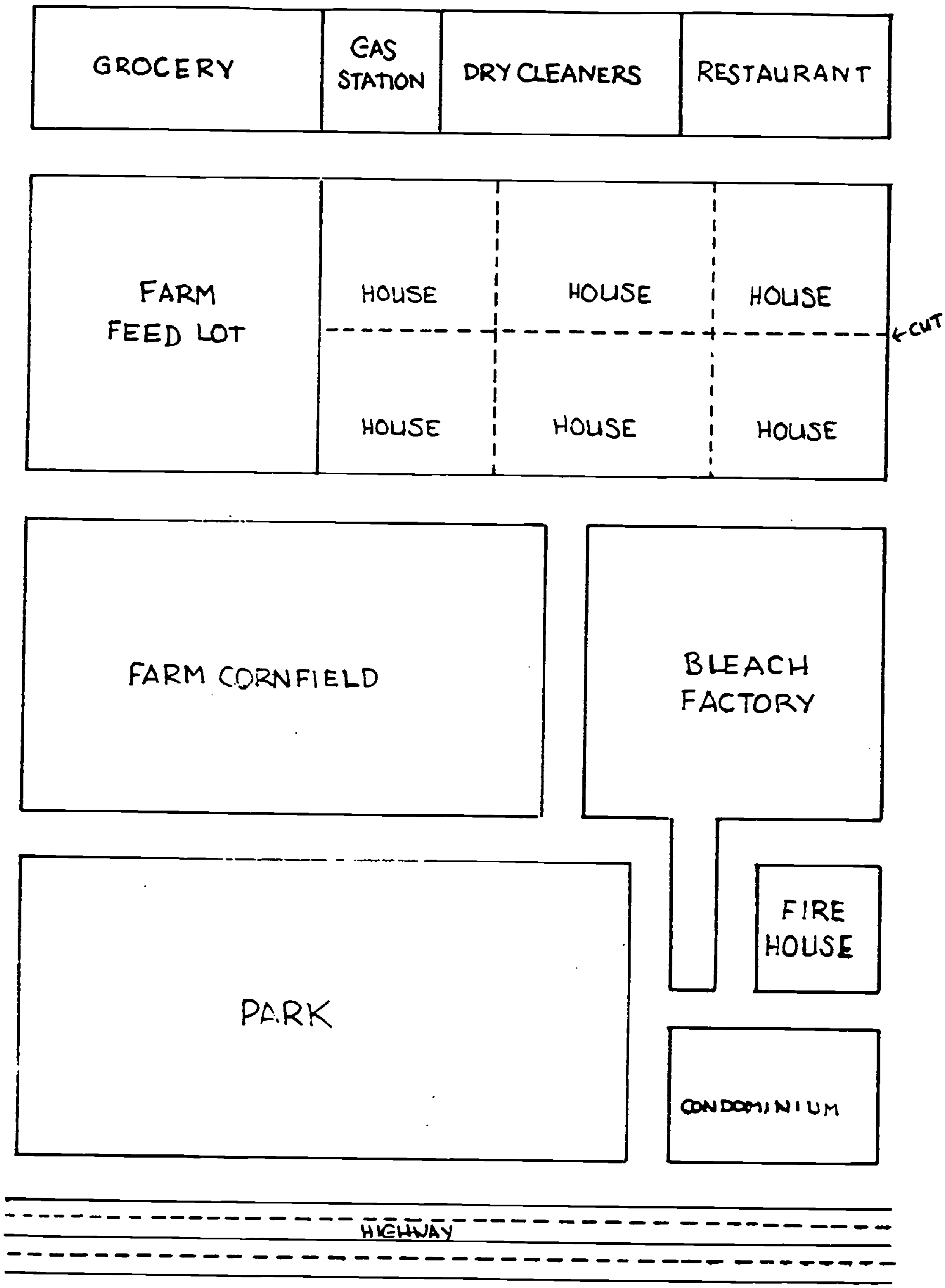
1. What are pollutants? Give two examples from the exercise.
2. What affects does industry have on downstream water supplies?
3. What affects does agriculture have on the water supply?
4. List possible solutions to the problems associated with growth.
5. Can you name people or organizations in your area that protect streams and rivers? What do they do?

Extension:

1. Trace a stream or river system that passes through your community from its source to the sea. Look at land use adjacent to the stream or river. How does that land use affect water quality?
2. Find out about organizations that work to protect streams. Some examples are Georgia Adopt-a-Stream, The Nature Conservancy and Trout Unlimited. Find out about what they do and how you can get involved.
3. Find out the quality of the local stream near the school.

Taken from Aquatic Project WILD, "Dragonfly Pond".




GROCERY
GAS STATION
DRY CLEANERS
RESTAURANT
FARM FEED LOT
HOUSE
HOUSE
HOUSE
CUT
HOUSE
HOUSE
HOUSE
FARM CORNFIELD
BLEACH FACTORY
FIRE HOUSE
PARK
CONDOMINIUM
HIGHWAY

Name those BUGS!

BIOLOGICAL

Objective: Students will learn how to evaluate the quality of a stream based on the diversity of aquatic insects found.
Location: Outdoors
Subjects: Math, Science
Time Frame: 60 minutes
Level: 6th - 12th grade

Background:

Biological monitoring involves identifying and counting macroinvertebrates. The purpose of biological monitoring is to quickly assess both the water quality and habitat of a stream. The abundance and diversity of macroinvertebrates found is an indication of overall stream quality. Macroinvertebrates are aquatic insects, crayfish, and snails that live in various stream habitats and are used as indicators of stream quality. Macroinvertebrates are present during all kinds of stream conditions--from drought to floods. These insects and crustaceans are impacted by all the stresses that occur in a stream environment, both man-made and naturally occurring. Follow steps one through three to complete a biological sample of your stream.

Note: **It is vital to know the potential upstream contaminants reaching the stream. Animal waste, agricultural runoff (pesticides, herbicides, etc.), industrial wastes, or sewage leaks can be hazards to students and you. If you find a stream with any of the above contaminants, a class should not collect samples in the stream or use proper precautions. Students should wear protective boots, gloves, and goggles when necessary. In case of serious contamination, notify local authorities.**

Materials:

kick screen or D-frame net
sorting pans or white plastic tub
tweezers or forceps
pencils and clipboard
hand lens
Adopt-A-Stream survey sheet (appendix C-4)
SOS Macroinvertebrate guide (appendix C-2)
rubber waders or old tennis shoes
rubber gloves (dishwashing gloves)

Optional:

preservation jars or baby food jars
rubbing alcohol, for preservation
bucket with screen bottom
(for muddy bottom sampling)

Procedures:

1. Find a sampling location in your stream. Macroinvertebrates can be found in many kinds of habitats--places like riffles (where shallow water flows quickly over rocks), packs of leaves, roots hanging into the water, old wood or logs, or the stream bed. **If present, riffle areas will have the most macroinvertebrates. If you have a stream with riffles, follow step 2a. If your stream has a muddy or sandy bottom (and no riffles), you will sample using the method in step 2b.** Sample the same stretch of stream each time, to ensure consistency (for example 50 yard stretch). Sample every three months, approximately once each season (spring, summer, fall and winter).

For streams with riffles:

2a. In this "rocky bottom" method, you will sample two different habitat--riffles and leafpacks. First, identify three riffle areas. Collect macroinvertebrates in all three riffles with a kick seine, sampling a 2 x 2 foot area (the kick seines are usually 3 x 3 feet). Look for an area where the water is 3 to 12 inches deep. Place the kick seine downstream and firmly wedge the seine into the streambed. Gently rub any loose debris off rocks and sticks so that you catch everything in the seine. When you have "washed off" all the rocks in a 2 x 2 foot area, kick the streambed with your feet. Push rocks around, shuffle your feet so that you really kick up the streambed. Now gently lift the seine, being careful not to loose any of the macroinvertebrates you have caught. Take the seine to an area where you can look it over or wash the contents into a bucket. Now look for decayed (old, dead) packs of leaves next to rocks or logs or on the streambed. Add 4 handfuls of decayed leaves to your sample. The total area of stream you will sample is 16 square feet.

For muddy bottom streams:

2b. In this method, you will sample three different habitats, using a D-frame (or dip) net. The habitats are: vegetated margins, wood debris with organic matter, and sand/rock/gravel streambed (or substrate). In this method you will scoop the stream a total of 14 times or 14 square feet. Each scoop involves a quick forward motion of one foot. To maintain consistency, collect the following numbers of scoops from each habitat each time you sample:

- 7 scoops from vegetated margins
- 4 scoops from woody debris with organic matter
- 3 scoops from sand/rock/gravel or coarsest area of the stream bed

As you collect your scoops, place the contents of the net into a bucket. Separate the samples collected from the rocky stream bed and vegetated

margin or woody debris samples. Keep water in the bucket to keep the organisms alive. Note descriptions below of each muddy bottom habitat and collection tips:

Vegetated margins

This habitat is the area along the bank and the edge of the waterbody consisting of overhanging bank vegetation, plants living along the shoreline, and submerged root mats. Vegetated margins may be home to a diverse assemblage of dragonflies, damselflies, and other organisms. Move the dip-net quickly in a bottom-to-surface motion, jabbing at the bank to loosen organisms. Each scoop of the net should cover one foot of submerged (under water) area.

Woody debris with organic matter

Woody debris consists of dead or living trees, roots, limbs, sticks, leafpacks, cypress knees and other submerged organic matter. It is a very important habitat in slow moving streams and rivers. The wood helps trap organic particles that serve as a food source for the organisms and provides shelter from predators, such as fish.

To collect woody debris, approach the area from downstream and hold the net under the section of wood you wish to sample, such as a submerged log. Rub the surface of the log for a total surface area of one square foot. It is also good to dislodge some of the bark as organisms may be hiding underneath. You can also collect sticks, leaf litter, and rub roots attached to submerged logs. Be sure to thoroughly examine any small sticks you collect with your net before discarding them. There may be caddisflies, stoneflies, riffle beetles, and midges attached to the bark.

Sand/rock/gravel streambed

In slow moving streams, the streambottom is generally composed of only sand or mud because the velocity of the water is not fast enough to transport large rocks. Sample the coarsest area of the streambed--gravel or sand may be all you can find. Sometimes, you may find a gravel bar located at a bend in the river. The streambed can be sampled by moving the net forward (upstream) with a jabbing motion to dislodge the first few inches of gravel, sand, or rocks. You may want to gently wash the gravel in your screen bottom bucket and then discard gravel in the water.

If you have large rocks (greater than two inches diameter) you should also kick the bottom upstream of the net to dislodge any borrowing organisms. Remember to disturb only one foot upstream of the net for each scoop.

Each time you sample you should sweep the mesh bottom of the D-Frame net back and forth through the water (not allowing water to run over the top of the net) to rinse fine silt from the net. This will avoid a large amount of sediment and silt from collecting in the pan, which will cloud your sample.

3. Place macroinvertebrates in a white sorting pan or plastic sheet. Separate creatures that look similar into groups. Use the SOS

identification guide to record the types and numbers of each kind of insect. As you sort through your collection, remember that each stream will have different types and numbers of macroinvertebrates. Calculate a score for your stream using the index on the Adopt-A-Stream Survey form. Use the table below to interpret your results.

If you find:	You may have:
Variety of macroinvertebrates, lots of each kind	Healthy stream
Little variety, with many of each kind	Water enriched with organic matter
A variety of macroinvertebrates, but a few of each kind, or **No** macroinvertebrates but the stream appears clean	Toxic pollution
Few macroinvertebrates and the streambed is covered with sediment	Poor habitat from sedimentation

Questions:

1. If you find low diversity of macroinvertebrates in a stream (Index value equals less than 11), and water quality appears good, what may be influencing your stream? Hint-Is there a lot of sediment in the stream? Where do macroinvertebrates live?
2. If you sampled your stream in the winter and then found a lower diversity index in the summer, does that mean your stream has been negatively impacted? (Not necessarily, there are seasonal variations to the macroinvertebrate populations).

Extension:

1. Enlarge pictures of aquatic insects, laminate and put on poster board. Enlarge names of insects and have students match.
2. Start a regular monitoring program of a local stream. Sample quarterly.
3. Sample different streams and compare results. Be sure and look at the stream habitat AND water quality as influences on your results.

Based on Georgia Adopt-A-Stream

Adopt-A-Stream Chemical Monitoring

CHEMICAL

Objectives: Students will gain information regarding the conditions of streams by performing chemical water quality tests and interpreting the data. Dissolved oxygen, temperature and pH will be tested in this exercise.

Location: Indoors/Outdoors

Time Frame: Two 60 minute session

Subjects: Biology, Chemistry, Ecology

Level: 6th - 8th grade

Background:

Chemical testing allows information to be gathered about specific water quality characteristics. A variety of water quality tests can be run on fresh water - including temperature, dissolved oxygen, pH, water clarity, phosphorus, nitrogen, chlorine, and alkalinity. The basic set of tests for Adopt-A-Stream groups include temperature, pH, settleable solids, and dissolved oxygen. Advanced tests include alkalinity, phosphate and nitrate. These tests allow volunteers to take the "life signs" of their stream.

In this exercise, two water samples will be compared. The first will be run inside on tap water and simple solutions. The second will be a free flowing stream. A regular sampling program can be started, but because water conditions can vary weekly, daily or even hourly, frequent and regular sampling should be conducted (weekly or monthly).

Water temperature is important in determining which species may or may not be present in a stream system. Temperature affects feeding, reproduction, and the metabolism of aquatic animals. Not only do different species have different requirements, but the optimum temperature may change for each stage of life. Fish larvae and eggs usually have narrower temperature requirements than adults.

pH tests indicate the amount of hydrogen ions in the water. A range of pH 6.5 to pH 8.2 is optimal for most aquatic organisms. Rapidly growing algae or submerged aquatic vegetation removes carbon dioxide (CO_2) from the water during photosynthesis, increasing the pH levels.

Dissolved oxygen (DO) is critical to many forms of aquatic life. DO is measured in parts per million or ppm. One ppm is equal to one milligram of oxygen dissolved per one litter of water. DO levels below 3 ppm are stressful to most aquatic organisms. DO levels below 2 or 1 ppm will not support fish; levels of 5 to 6 ppm are usually required for growth and activity. Colder water can hold more dissolved oxygen, so the highest DO levels will be found during the winter. Streams that have a high velocity and flow over rocky areas (mountain streams) likewise will have higher DO levels because the water mixes with the air more frequently.

Note: Because the quality of the stream may not be known, it is best to take

precautions with students in the water. Gloves and wading boots in the stream are a must.

Note: Many of these lesson plans require a class to collect samples from nearby streams. It is vital to know the condition of the stream before sampling. Animal waste, agricultural runoff (pesticides, herbicides, etc.), industrial wastes, or sewage leaks can be hazardous to you and your students. If you find a stream with any of the above contaminants, a class should not collect samples in the stream or use proper precautions. Students should wear protective boots, gloves, and goggles when necessary or when stream conditions are unknown. In case of serious water quality problems, notify local or state authorities.

Materials:

dissolved oxygen test kit (Chemetrics, LaMotte or Hach)*
pH paper or test kit (fish tank test kit, Chemetrics, LaMotte or Hach)*
thermometer*
Rubber gloves
Safety glasses
Container to bring back waste chemicals (old milk jug)
Bucket with rope (if sampling off a bridge or deep water)
Pencil
First Aid Kit
Lemon juice
Ammonia or Baking Soda
Plastic cups

*certified thermometer, LaMotte or Hach kits used in collecting quality assured data for Georgia Adopt-A-Stream. **Note**-LaMotte and Hach kits have concentrated sulfuric acid, may be appropriate for older students.

Procedures:

Part one:

1. Preparing the students to perform these tests on a stream requires the students spend time inside practicing with the kits. Review chemical monitoring instructions and safety precautions found in the appendix.
2. Set out the lemon juice, ammonia or baking soda, an aerated water sample(aerate with air hose), and a water sample that is not aerated. Add approximately ½ cup of lemon juice or ammonia to a half gallon of water.
3. Set out thermometers, test kits and water samples.
4. Divide the class into groups and have one member of each group collect a small amount of each sample in a cup. Note: the oxygen level in the aerated sample will quickly change as oxygen diffuses back into the

atmosphere.

5. Have each group conduct either the dissolved oxygen test or take the temperature and determine the pH of the samples. If time permits, have the groups switch tests so all students have run all tests.
6. Have students record results on Adopt-A-Stream data sheet or blank piece of paper. Compare results.

Discussion:

1. What values did you obtain for each sample? Why is the oxygen level higher in the sample that was aerated? Why does the lemon juice sample have a lower pH then the tap water? Why does the ammonia sample have a higher pH than the tap water?
2. Calculate the percentage difference between answers. To meet Georgia Adopt-A-Stream quality assurance criteria, duplicate tests results should be within 15 percent.
   Percent difference = [(1st duplicate-2nd duplicate)/average of duplicates] x 100
3. What values for DO, temperature and pH to you think will be found in a fresh water stream? Why?
4. Why are these parameters important to understanding the health of a stream?

Part Two:

1. Locate a nearby stream, pond or drainage ditch. Look on county or topographical maps to find a waterway or ask local water authorities or extension officers.
2. Review safety precautions at site. Make sure students wear safety glasses and gloves. Know location of nearest phone. Bring first aid kit.
3. Divide the class into groups. Rinse glass tubes or containers twice with stream water before running each test. Collect water samples from mid-stream and mid-depth. Measure the air and water temperature in the shade, avoid direct sunlight.
4. Have each group measure DO, temperature and pH.
5. Record data on Adopt-A-Stream data sheet (or one of your own).
6. Compare results at site or back in classroom.

Discussion:

1. What values did you obtain for each sample? Why is the oxygen level higher or lower than the classroom samples? Temperature? pH?
2. Calculate the percentage difference between answers. To meet Georgia Adopt-A-Stream quality assurance criteria, duplicate tests results should be within 15 percent.
3. What values would you expect at a different time of day? A different time of year?

Questions:

1. What does pH tell you about a stream? What is the optimum pH?
2. What is dissolved oxygen? How does it get into the water? What are the optimum ranges.
3. Why is temperature an important parameter to measure?
   Grades 9th-12th
4. What do phosphates and nitrates measure in a stream? Is a high amount of phosphate good for a stream?

Extension:

1. Start a regular chemical monitoring program. Test at least once a month at the same location and time of day. Keep detailed records of the chemical results and graph changes throughout the year. Be sure and register with Georgia Adopt-A-Stream!
2. Visit a different stream or river site once a month. Compare results between sites. How do the different watersheds compare and affect water quality? Are there any point or nonpoint discharges?

Based on Georgia Adopt-A-Stream

Fertile Green

BIOLOGICAL

Objective: Students will identify sources of fertilizer runoff and describe the effects fertilizer has on algal growth by performing an experiment with different water sources.
Location: Indoors
Time Frame: 2- 60 minute session
Subjects: Science, Math, Language Arts
Level: 6th - 8th grade

Background:

One of the problems facing streams is excess nutrients. Nutrients, mostly nitrogen and phosphorus, act as a fertilizer causing an increase in the growth of algae and other aquatic plants. Too much nutrients can cause algal blooms, which increase oxygen demand and can limit oxygen available to fish and aquatic breathing organisms. It is important to remember nutrients are important to streams, but when the nutrient load is in excess, it is harmful to the organisms living in the stream.

Nutrients naturally occur in streams from leaf litter and plants. In fact, the proper amount of nutrients produces abundant plant life. However domestic sewage, industrial wastes, chemical fertilizers from lawns and fields can reach the stream and build up. Long term nutrient enrichment may cause a lake to be choked by vegetation, covered with scum, and have a foul odor. In addition, a heavy plant bloom can reduce the oxygen and result in a fish kill.

Materials:

Clear plastic containers, 4/group (ie. 2 liter soda containers)
Measuring spoons
Water samples from stream, lake or pond
Plant fertilizer
Tap water
Dissolved oxygen kit (optional)
Camera and Film (optional)
Photographs of water bodies with algal problems and eutrophication (optional)

Preparation:

Fill several buckets or other containers with tap water and let them sit for a day or so to allow any chlorine to dissipate.

Prepare fertilizer according to the package directions and double its strength. For example, if the directions call for one teaspoon per quart add two teaspoons of fertilizer to one quart of the water sample.

Procedures:

1. Explain to the students that water pollution is (1)any human-caused contamination of water that lessens its value to human and nature; and (2)phosphorus entering lakes in runoff from fertilized area can cause heavy algal blooms and excessive weed growth in lakes.
2. Make a list of all potential sources of nutrients which might wash into a waterbody after a heavy rain. The list should include agriculture, forests, plant nurseries, golf courses, home or business landscapes, and home gardens. Remember, the leaf litter in the stream is also a source of nutrients.
3. The students will be observing the effects of fertilizer runoff on a water body. The plant fertilizer will represent the fertilizer being washed into streams, rivers, and lakes after a heavy rain.
4. EXPERIMENT:
   Have the students bring water samples to class taken from a stream, lake, pond, aquarium, or puddle and place on a table with the bucket of tap water.

   Divide the class into groups of two or three. Have each group get four jars. Label the jars:

   #1 Tap Water (Control)
   #2 Tap water + fertilizer
   #3 Aquarium/pond/lake
   #4 Aquarium/pond/lake + fertilizer

   Have students fill each jar with the appropriate water sample. Then have them add the appropriate amount of fertilizer to jars #2 and #4 (double strength of instructions).

   Set all four jars in window sill or a place where there is good light. Be sure not to place them in a drafty or cold location because constant temperature is needed for best algal growth. STUDENTS MUST WASH THEIR HANDS AFTER PREPARING JARS.

5. Have each group write a hypothesis of what they think will happen.
6. Observe the jars every day for a week and then once a week for a month. Record any changes in the jars on a data sheet. You may want to photograph the jars. If possible, check the dissolved oxygen in the jars once a week at THE SAME TIME OF DAY (oxygen levels vary throughout the day and night)
7. At the end of the experiment, have each group write their result in a report. As a class, discuss the results.

Questions:

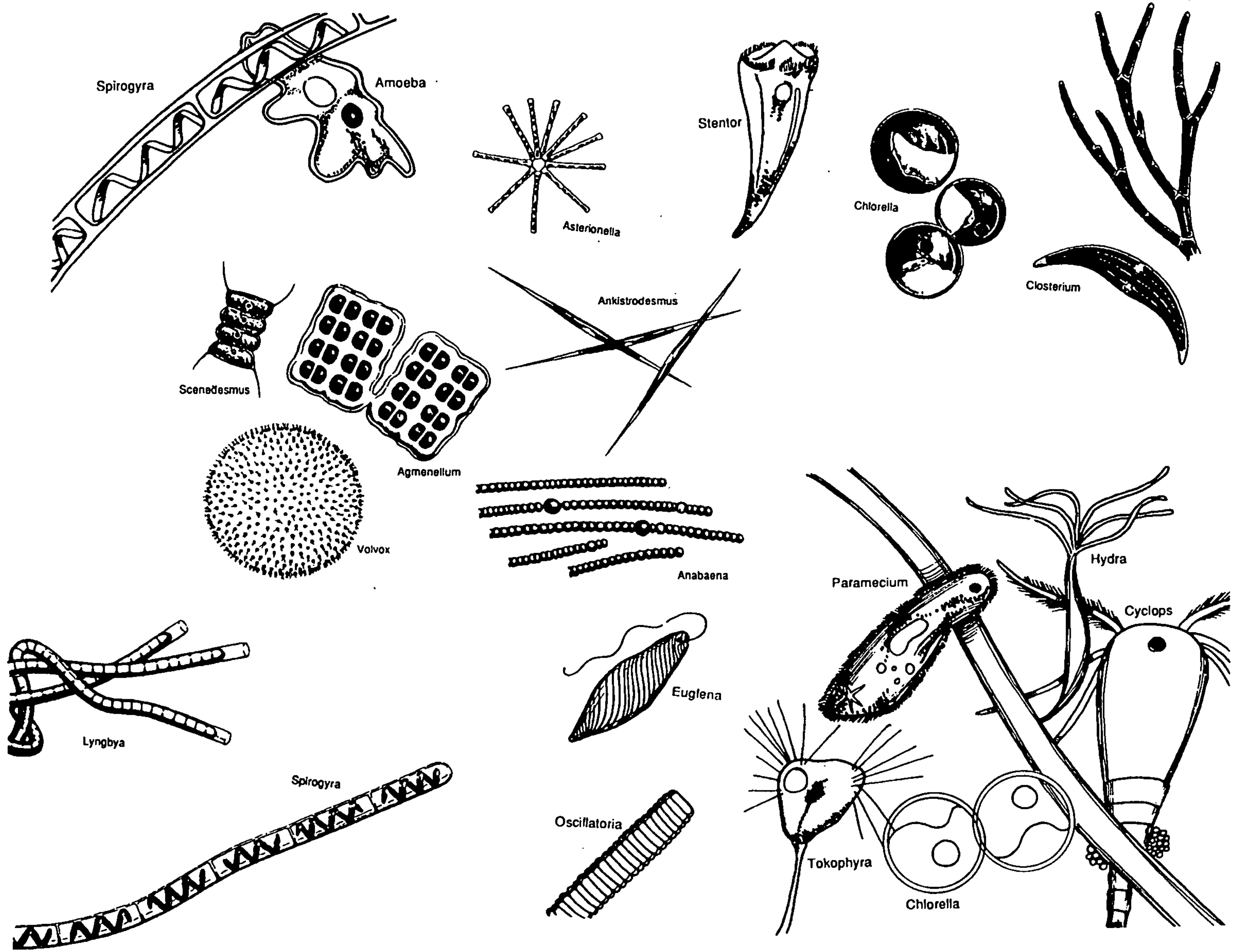
1. Which jar has the greatest algal growth? Why?
2. Which jar had the least algal growth? Why?
3. As algal growth increases, what happens to the dissolved oxygen?
4. What happens to the oxygen levels at night? Why?
5. Name land uses and activities that contribute nutrients to streams.
6. What would result if more fertilizer were used?
7. What effects do nutrients have on aquatic life?

Extension:

1. Follow the same procedures listed above, but test for changes in dissolved oxygen rather than algal blooms.
2. Collect additional water samples from different locations of a stream or pond. Test the dissolved oxygen levels in each sample. Note the land uses of surrounding the sampling area. Have the students determine that land uses affect the oxygen level of a stream.
3. Observe algae under a microscope, have students identify types of algae based on handout.

Based on Environmental Resource Guide.

Aquatic Microorganisms



Watershed Walk

WATERSHED

Objective: Students will understand the concept of a watershed, identify a river's watershed system, and describe the immediate watershed in which they live.
Location: Indoors
Time Frame: 60 minutes
Subjects: Geography, Science, Social Studies
Level: 6th - 12th grade

Background:

A watershed is all the land area that contributes runoff to a particular body of water. It is a catch basin that guides all the precipitation and runoff into a specific river system. Changes in a watershed affect all living and non-living things within its boundaries. For example, a mostly forested watershed that is logged will result in changes in water flow and sediment entering streams. Sedimentation in turn will reduce the diversity of macroinvertebrates found in streams.

Perhaps the single most important thing to remember about watersheds is that they are single units connected to other watersheds as they are traced downstream. What affects a watershed in one place eventually affects other sites downstream. Impacts can accumulate as water proceeds downstream.

A topographic map can be used to determine the contours of a watershed, identify some land use practices, and plan best management programs to prevent or reduce pollution. To effectively use topographic maps, it is necessary to understand the information depicted. More information on watershed mapping is provided in Appendix A-1.

During a visit to a stream, students can learn about a watershed. The land use around the area affects the quality of a stream. For example, poor agricultural practices next to a stream may add pesticides and excessive fertilizer to the stream. Urban land uses, such as parking lots and roads contribute small amounts of oil and gas to stormwater . Students should take note of the land use and the condition of the streams. Asking questions like "Is the water silty", "Is the water a green color" and "Are there signs of pollution" will help identify the quality of the stream. See appendices A-2 and B-1.

Materials:

Several copies of Adopt-A-Stream "Watershed Walk" see Appendix A-5.
Copies of a topographical map (Scale 1:1,000,000) of the river watershed nearest the school. There needs to be a map for every group in the class. A large map of Georgia (Scale 1:500,00) showing these rivers and its tributaries

would be helpful. Topographic maps and the Georgia maps can be obtained from the Geologic Survey Branch of Georgia Environmental Protection Division, 404-656-3214
Markers, crayons, or transparency pens
Acetate sheets or laminate for maps (optional)

Preparation:
It is vital to know the potential upstream contaminants reaching the stream. Animal waste, agricultural runoff (pesticides, herbicides, etc.), industrial wastes, or sewage leaks can be hazards to students and you. If you find a stream with any of the above contaminants, a class should not collect samples in the stream or use proper precautions. Students should wear protective boots, gloves, and goggles when necessary. In case of serious contamination, notify local authorities.

Procedures:
Part One:

1. Discuss the following terms: watersheds, runoff, non-point source pollution, and land uses. Have each student look at the "Major Watersheds of Georgia" map in Appendix A-1.
2. Make copies of the Adopt-A-Stream "Watershed Walk" and "Visual Survey" forms from Appendix A-5.
3. Take the students to a river or stream, survey a 1/4 mile bank, and fill out the forms to determine land use, erosion, water color, water clarity, animal life, and human impacts on the stream.
4. In the classroom, discuss the categories and overall condition of the stream. If you suspect the stream to be polluted, ask what can be done to improve the quality of the stream? What is affecting the health of the stream?

Part Two:

Laminate the local and topographical maps so they can be used again.

1. Divide the class into groups of 3 or 4. Give each group a city or county map.
2. Have students find their own town or community on the map.
3. Have students locate the river or stream closest to the school and trace over it with a marker or crayon.
4. Have the students locate the streams that join the main river and trace over them.
5. Give each group a topographical map.
6. Have students find and trace the section or tributary of the main river that flows closest to them with a transparency pen.
7. Ask students to outline the watershed. Detailed instructions are provided in Appendix A-1.

Questions:

1. What are the landuses in your area? (urban with roads, parking lots and buildings, suburban with houses and lawns, rural with farms)
2. How might these land uses affect the water in the watershed's streams ? (fertilizers, pesticides, silt and other pollutants may run into the river) See appendix A-2.
3. How is the volume of water affected by the watershed? (the size of the watershed, land uses, and vegetation will affect the amount and quality of runoff that reaches a stream.)
4. Will the conditions in your watershed affect others downstream? How?
5. Where does all of the water eventually go? (Gulf of Mexico or Atlantic Ocean) Can you follow the rivers on a map all the way?

Extension:

1. Have students identify the rivers that make up the main river watershed. Students should be able to explain how the different waters of the main river watershed are interconnected. Have them draw an imaginary river system, labeling the sources and tributaries of the river, and outlining and naming the watershed.

2. Have the students collect newspaper or magazine articles that reflect the impact of water in one area of the state on others. These could be current articles or historical ones obtained from the library.

Forms are provided by the Georgia Adopt-A-Stream program.

Rolling down the River

WATERSHED

Objective: Students will be able to compute the velocity and discharge of a stream.
Location: Outdoors
Subjects: Math, Physics, Science
Time Frame: 60 minutes
Level: 6th - 12th grade

Background:

Knowing the velocity of a stream is important for determining the aquatic organisms that live at a stream site. Some organisms, such as trout, prefer quickly moving, highly oxygenated water. Other aquatic critters adapt well to slow moving warm waters. Velocity is an important characteristic of your stream. The velocity of a stream equals the distance the water travels per unit of time.

Volume and discharge are also important characteristics and can be easily calculated on your stream. The volume of water flowing through your stream is the area of the stream channel multiplied by stream length. The discharge is the volume per unit of time. The total discharge of a stream is important, how much water is being drained from your watershed? The discharge may vary as land use in the watershed changes and from season to season.

Note: **It is vital to know the potential upstream contaminants reaching the stream. Animal waste, agricultural runoff (pesticides, herbicides, etc.), industrial wastes, or sewage leaks can be hazards to students and you. If you find a stream with any of the above contaminants, a class should not collect samples in the stream or use proper precautions. Students should wear protective boots, gloves, and goggles when necessary. In case of serious contamination, notify local authorities.**

Materials: 50 foot piece of string or 5, 10 foot sections (marked in 1-foot intervals).
Yardstick
Orange
Stop watch
Pencils and notebooks
Copies of water flow chart.

Procedures:

Note: Do not choose a deep pool or riffle, flowing water is dangerous and students should not be above their knees in the water. Also, consider the flow of the stream, if it is moving too fast do not let the students get in the water.

For grades 6th - 8th:

1. Discuss the following terms: velocity and discharge.
2. Using the string, have the students mark off a 50-foot section (length) of a stream moving downstream. Position two students every 10 feet of the measured section. One will hold the string and one will record times.
3. Designate one student to be the timer. This student will call out times as the orange floats past each 10 foot section.
4. Release the orange upstream. Begin timing. Record results. Repeat twice.
5. Calculate stream velocity as follows:

   V = Distance (feet)/time (second)

For grades 9th - 12th:

1. Discuss velocity, volume and discharge.
2. Follow steps 1 through 5 above.
3. Divide the class into groups of four. Have each group use a string to make several measurements (approx. 4) of the width of the stream within the 50-ft measured section. Record these numbers on the provided worksheet.
4. Have the students make several depth measurements of the stream using the yardstick and record the values on the data sheet.
5. At this point, each group should draw two views of the stream: a top view including widths and a cross section with depths marked on the diagram.

In the classroom, each group should:

6. Plot a stream profile. The profile plots the depth of the stream versus the width of the stream.
7. Average the depth measurements to get one number for the depth. Average the stream widths to get one number for the width.
8. Multiply width x depth x length (10 feet) to get the volume of water in that section of the stream. Explain volume as the amount (how much) water is in a certain area.
9. Average the time it takes for the orange to travel 10 feet. The creek's discharge is the volume of water that flows in a certain amount of time. Have each group determine how much water flows by in one second, one minute, and one hour.

Questions:
For grades 6th - 8th:

1. Calculate the velocity of the stream if the orange flows at a rate of 100ft in 1.5 minutes.
2. Can you name two animals that live in fast moving water?
3. What does the velocity tell you about the watershed?

For grades 9th - 12th:

1. If the average depth of the stream is 4 ft and width is 7.5 ft and it took the orange 10 seconds to travel the 10 foot length of the stream, what is the volume?

2. If two streams drain equal sized and comparable watersheds, and one watershed is forested while the other is urban, which will have a greater discharge of water? Why?

Extension:
For grades 6th - 8th:
1. Perform this same exercise, but calculate the velocity of two different sites; a riffle and a pool.

For grades 9th-12th:
1. Calculate the amount of water entering the stream from the watershed. Calculate the area of a watershed. Have the students look at a topographic map and draw out the watershed. Estimate the area of the watershed with a dot grid or a local Soil Conservation Service can measure the watershed. Find out the average annual rainfall for the area by contacting the SCS. Multiply these values and determine the volume of water in the stream. Calculate the value in gallons.

Based on Georgia Adopt-A-Stream

Student Data Sheet:

Velocity

Distance traveled	Time to travel distance (sec.)	Time to travel each 10 ft. section	Velocity (10 ft./sec.)
Average Velocity			

Volume and Discharge

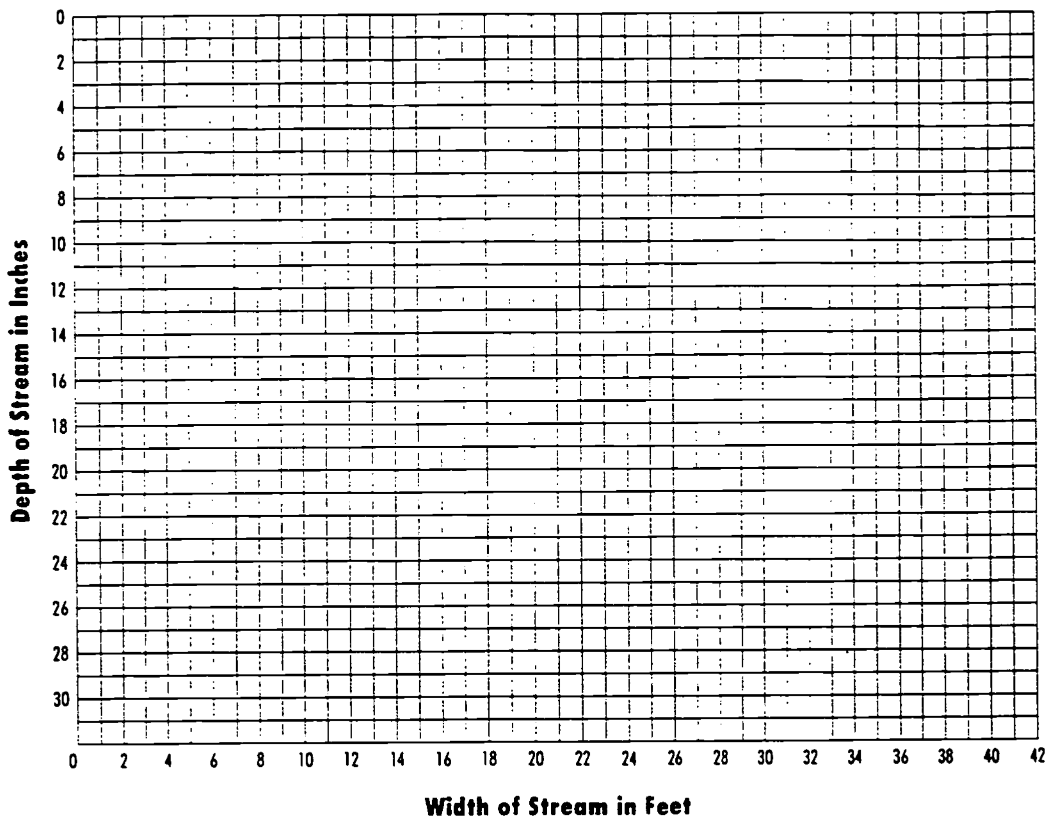
Width measurements:	Depth measurements:
Average -	Average -

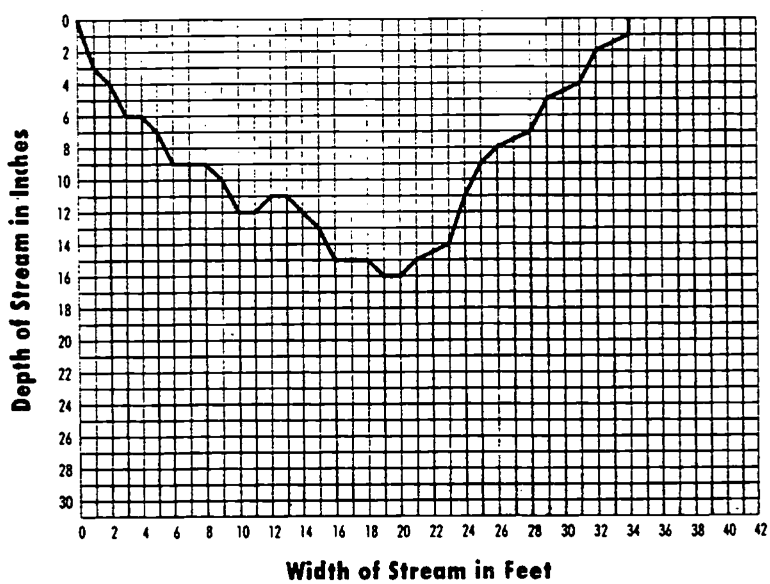
Calculations:

Volume = width x depth x length

Discharge = volume (ft^3)/time (sec.)

STREAM PROFILE SAMPLE





Sample
(Students should make their own stream profile.)

87

Lethal lots

NONPOINT

Objective: Students will explain how bioassay methods are used to determine toxicity. By using *daphnia,* the students will determine the toxicity of an urban runoff water sample.

Location: Indoors/Outdoors

Time Frame: 3-60 minutes classes

Subjects: Science, Ecology, Biology, and Chemistry

Level: 9th - 12th grade

Background:

Daphnia are small freshwater crustaceans that are food sources for many other animals. They are very sensitive to changes in temperature and water chemistry. For this reason, they are sometimes used for detecting the presence of toxic substances in a water supply. The examination of such organisms to detect the presence and relative amounts of toxic substances in a water supply is called biomonitoring. The technique used in this activity is called bioassay. A bioassay is a method used to test the concentration of a substance by observing its effects on the growth of an organism under controlled conditions.

Toxic chemicals in a water supply can harm the plants, animals, and humans that depend on it. Toxic chemicals and other pollutants can enter a water supply from many sources such as urban and rural polluted runoff, leaking landfills, and mining areas. Toxic chemicals from a parking lot, for example, might include oil, antifreeze, brake fluid, lead, chromium, iron, and manganese. For additional information on non-point source pollution, see Appendix B-1.

Runoff from large areas of pavement is likely to contain pollutants. Since none of the water or pollutants can be absorbed thought the pavement, the water runoff is unfiltered. In this activity, the toxicity of runoff from the school parking lots will be determined.

Materials: 3 liters of runoff water from the school parking lot (collect after a storm)
Clean sponge, turkey baster, or rulers and clean dust pans to collect water
Plastic containers with lids to store sample
50 live *daphnia* (available from biological supply company)
5 gallon container or aquarium
Daphnia food:
- tropical fish food
- yeast
- alfalfa
- distilled water

Aerator
Compound microscopes
Microscope slides and cover slips
Blender
1 aquarium thermometer
Grease pencil or permanent marker
Labels or masking tape
30 eyedroppers
50 ml. cylinder
5-500 ml. beakers
30-50 ml. beakers
2-cycle semi-log graph paper
Saturation Concentration Dissolved Oxygen data sheet
Data sheet
Daphnia media:
- 20 liters distilled water
- $NaHCO_3$
- $MgSO_4$ X H_2O (Epsom salt)
- KCL
- $CaSO_4$.

Water quality test kit (optional)
Daphnia anatomy sheet (optional)

Group Discussion:

1. Discuss with the students the role of urban runoff as a non-point source of pollution. Explain that runoff can contain toxic chemicals and pavement runoff will not absorb into the earth allowing it to be naturally filtered. What type of toxic chemicals could be in the runoff? What are the sources of these toxic chemicals? (Additional information in Appendix B-1). Note: Explain to the students that storm water runoff is usually piped directly into local streams. The runoff does not go to a treatment plant first before entering a stream. Urban storm water may contain sediment, debris, and toxic chemicals such as herbicides, pesticides, oil, antifreeze, and heavy metals.
2. Discuss that some organisms are more sensitive to pollutants than are others. Why are these sensitive organisms good indicators of water quality? (It is easier to detect low concentrations of pollutants with sensitive organisms.)
3. Point out the disappearance of certain plants or wildlife in a water body is an indicator of changing water quality.
4. Toxic chemicals can enter a water supply from many sources such as agriculture, mining, construction sites, landfills, farms, homes and forestry operations.

Preparation:

You may wish to have the students perform the following:

1. When *daphnia* arrive, acclimate them to the laboratory aquarium. Have the water temperature the same in the shipping container and in the aquarium before transferring daphnia.

   The culture medium in 5 gallon(20 liter) container/aquarium should be prepared as follows:

   Fill a clean 20 liter container to the 19 liter mark with distilled water. Pour out approx. 500 ml into a separate clean beaker and completely dissolve the following chemicals in it before adding back to the 20 liter container:

   2.88 g $NaHCO_3$
   1.80 g $MgSO_4$ X $7H_2O$ (Epsom salt)
   0.45 g KCl

   Remove another liter from the 20 liter container into another clean container, add 1.80 g $CaSO_4$. Add this mixture back to the 20 liter container.
   Aerate the mixture for two hours using an aquarium aerator
   Allow the mixture to reach room temperature before adding *daphnia*.

2. Have the daphnia food prepared and feed them once a day :

   6.3 g tropical fish food
   2.6 g yeast
   0.5 g alfalfa
   500 ml distilled water

   Blend all ingredients for five minutes on low speed. Cover and let stand in refrigerator for one hour. Pour off top liquid and save in refrigerator. Dispose of the rest.
   Feed once a day.
   Food is good for two weeks

3. Two days before the experiment, prepare new culture media to be used in the experiment.

Procedures:

Part one:

1. Check the *daphnia* one day prior to running the experiment to ensure that the culture is healthy. If 10 percent or more of the daphnia die between their arrival and this time, you may wish to reorder. Because *daphnia* are sensitive, they must be protected from hair spray, perfume, smoke, bug repellant, and the room temperature should be kept as a constant 68 degrees F.

2. Have the students collect approximately 3 liters of runoff from the school parking lot after a rainstorm in a clean container with a lid and store in the refrigerator (up to 2 weeks) until time for the experiment. Collect the runoff sample by one of the following:
   A clean sponge to absorb the water and wring into a container, or
   A turkey baster to siphon the water into a container, or
   A cleaning squeegee to push the water into a dust pan and then into a container.

3. Place **10 *daphnia* containing embryos** in each of the five 500ml beakers with 300ml of culture medium and 0.5ml of food. Make sure culture media is at room temperature. Because air bubbles can become trapped under the daphnia, place the daphnia into the media without pouring the sample. Use an eyedropper and release them slowly into the media.

   Note: Do not use *daphnia* with ephippia or dark eggs because they will not hatch from them in time for the experiment.

4. Use the newborn *daphnia* found in the beakers the next day for the experiment. Newborns will be smaller than the parent. Newborns are used to eliminate some sampling error from the experiment because this assures all organisms used in the experiment are the same age. (If you do not have time to remove newborns, use *daphnia* in the culture which do not have embryos or ephippia.)

5. If water quality kits are available, test the dissolved oxygen of the media. The DO should be 40 percent saturation or greater. Otherwise, the *daphnia* will be stressed and die from low DO. Try using aerators if the DO is low.

Part two:
1. Divide the students into teams of two.
2. Give each team a compound microscope and *daphnia* (on a slide) to observe.
3. Have the students distinguish between daphnia with embryos and ephippia.
4. In the laboratory, have the students prepare and label four 50ml beakers of each of the following concentrations of runoff water. Each group will be responsible for setting up the experiment and recording the results.

Concentrations	Runoff Water	Culture Media
100%	40 ml	0 ml
50%	20 ml	20 ml
25%	10 ml	30 ml
10%	4 ml	36 ml
5%	2 ml	38 ml
2.5%	1 ml	39 ml

5. Have the students label each beaker using tape or a grease pencil. Have the student write the date, temperature, and time the experiment begins. If a DO kit is available, test the dissolved oxygen.
6. When the beakers are ready, introduce five *daphnia* into each of the beakers.
   *Use an eyedropper to transfer *daphnia*
   *Record time on each beaker
   * Do not collect *daphnia* from top or bottom of beaker.
   DO NOT FEED *DAPHNIA* DURING EXPERIMENT
7. Have the students count the number of dead daphnia in each beaker at the end of 24 hours and 48 hours.
8. Distribute 2-cycle semi-log paper.
9. On semi-log paper, the lower half of the paper goes between 1-10 in logarithmic steps on the y-axis and the upper half goes from 10-100 in the same fashion. Have the students plot percent mortality (on the x-axis) and percent concentration (on the y-axis). Explain that the graph will help the students determine at which concentration the parking lot runoff has an LC50.
10. Explain LC50 or lethal concentration. This is the concentration of runoff where 50 percent of the *daphnia* die. On the percent concentration scale, have students locate the point at which 50 percent mortality occurred. This point is the LC50 for the experiment expressed as percent parking lot runoff volume. For example, if 25 percent concentration treatment results in 50 percent mortality, then report the LC50 as 25 percent. (NOTE: If the 2.5 % concentration treatment results in greater than 50% mortality, report LC50 as less than 2.5% or repeat the procedure using a dilute sample.

Questions:

1. Why were four beakers of each concentration used? (Replication)
2. What is the purpose of the control? (To make sure other factors beside the runoff didn't kill the *daphnia*)
3. Why do some *daphnia* die before others? (Some are more sensitive than others)

4. Why is an LC50 used instead of an LC100? (LC50 is more exact. It is difficult to extrapolate because 100 percent of the organisms are dead, the concentration used in the experiment killed them)
5. On the basis of your results would you consider the runoff from the school parking lot to be toxic?
6. What can you do to protect nearby streams? (Monitor regularly and filter stormwater before it enters the stream.)

Extension:

1. Invite someone from the Department of Natural Resources or Natural Resources Conservation Service to visit your school parking lot and discuss what best management practices could be used on your site to prevent pollution from begin funneled directly into water bodies. After the guest speaker, have the students design a "best management plan" or BMP for your school parking lots and work with school officials to get it implemented.

Taken from the Environmental Resource Guide, "Lethal Lots".

Name(s) ______________________ Date ______________

LETHAL LOTS

Site Name ______________________

Test Organism ______________________

Beginning Date/Time ______________________

Ending Date/Time ______________________

Your Sample:

Beaker # ______________

Concentration ______________

Dillution ______________

CHEMISTRY:

Test	Beginning	24-Hour	48-Hour
Temp.			
*DO			
*pH			
*Alkalinity			
*Hardness			

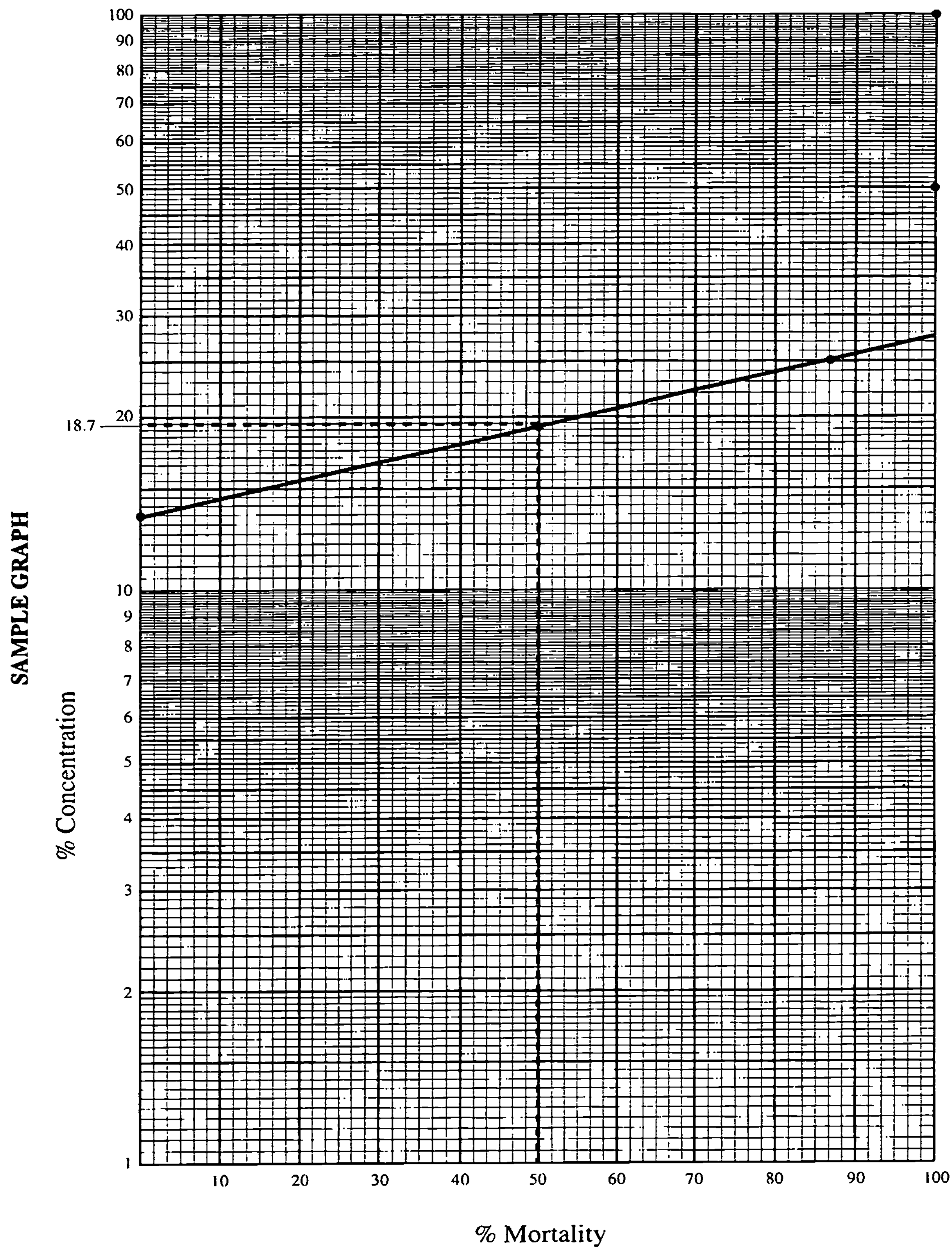
24-HOUR TEST/GROUP RESULTS:

Beaker #	# of Daphnia alive at concentrations					
	100%	50%	25%	10%	5%	2.5%
1						
2						
3						
4						
Control						

48-HOUR TEST/GROUP RESULTS:

Beaker #	# of Daphnia alive at concentrations					
	100%	50%	25%	10%	5%	2.5%
1						
2						
3						
4						
Control						

*Suggested tests using water test kit (optional).



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Adopt-A-Stream Chemical Monitoring

Objectives:	Students will gain information regarding the conditions of streams by performing chemical water quality tests and interpreting the data.
Location:	Indoors/Outdoors
Time Frame:	60 minute session
Subjects:	Biology, Chemistry, Ecology
Level:	9th - 12th grade

Background:

Chemical testing allows information to be gathered about specific water quality characteristics. A variety of water quality tests can be run on fresh water including temperature, dissolved oxygen, pH, water clarity, phosphorus, nitrogen, chlorine, total dissolved solids and salinity. Each of these parameters gives you specific information about your stream's "life signs".

Chemical testing should be conducted at least once a month because this type of testing measures the exact sample of water taken, which can vary weekly, daily and even hourly.

Temperature is one important factor which determines which species may be present in the system. Temperature affects feeding, reproduction, and the metabolism of aquatic animals. Not only do different species have different requirements, but optimum habitat temperature may change for each stage of life. Fish larvae and eggs usually have narrower temperature requirements than adults.

pH tests indicate the amount of hydrogen ions in the water. A range of pH 6.5 to pH 8.2 is optimal for most aquatic organisms. Rapidly growing algae or submerged aquatic vegetation remove carbon dioxide (CO_2) from the water during photosynthesis, increasing the pH levels.

Dissolved oxygen (DO) is critical to many forms of aquatic life for respiration. DO levels below 3 ppm are stressful to most aquatic organisms. DO levels below 2 or 1 ppm will not support fish; levels of 5 to 6ppm are usually required for growth and activity.

Phosphorous and nitrogen are nutrients found naturally in small amounts in streams. Unfortunately, many suburban and rural areas contribute excessive amounts of these nutrients to streams through fertilizer and livestock runoff. Too much phosphorous or nitrogen leads to algae blooms and fish kills.

Note: It is vital to know the potential upstream contaminants reaching the stream. Animal waste, agricultural runoff (pesticides, herbicides, etc.), industrial wastes, or sewage leaks can be hazards to students and you. If you find a stream with any of the above contaminants, a class should not collect samples in the stream

or use proper precautions. Students should wear protective boots, gloves, and goggles when necessary. In case of serious contamination, notify local authorities.

Materials:

Water quality testing kit (LaMotte or Hach)
(Should contain: dissolved oxygen, pH, temperature, phosphate and nitrate)
Imhoff Cone for settleable solids
Adopt-A-Stream survey sheet (see apendix D-3)
Rubber gloves
Safety glasses
Container to bring back waste chemicals (old milk jug)
Bucket with rope (if sampling off a bridge or deep water)
Pencil
First Aid Kit

Preparation:

In preparing the activity, it is important to visit the stream. Survey the stream for any dangers, a clear path to the stream, and permission to be on the land. In addition, see the note above.

Procedures:

1. Read through test kits in class. Practice tests in class with tap water if desired. Depending on your kit, directions may vary and some are difficult to follow.
2. At the stream, divide the class into groups of 4. Assign two tests per group. Make sure students are wearing safety glasses and gloves.
3. Measure the air and water temperature in the shade, avoid direct sunlight.
4. Rinse glass tubes or containers twice with stream water before running the test.
5. Collect water for the tests approximately midstream, mid-depth.
6. Perform DO, pH, phosphate, nitrate, settleable solids. An Adopt-A-Stream data sheet has been included for the students to record the stream data on for future comparisons.
7. Once all the parameters are collected, bring the data into the lab.
8. Have each group write the values on the board.
9. Have students share their results. Next to the parameters, have the students give one reason each parameter could be high or low.

Discussion:

With the water quality values, begin a discussion about potential water problems. Ask the students what accounts for the differences between each group's values. In

addition, discuss any parameter that do not fall into the optimum conditions.

Questions:

1. What does pH tell you about a stream? What is the optimum pH?
2. What is dissolved oxygen? How does it get into the water? What are the optimum ranges?
3. What do phosphates and nitrates measure in a stream? What are sources of phosphates and nitrates? Is a high amount of phosphate good for a stream?
4. Why is it important to run duplicate samples? Some groups tested for the same substance. How did the results compare? Account for any discrepancies.

Extension:

1. Visit several streams in your area and compare chemical monitoring results. Test each site at the same time of day to minimize diurnal fluctuations.
2. The Adopt-A-Stream program has been developed to help monitor and make local changes needed to protect our stream. Have the students begin a local Adopt-A-Stream program at a local stream, monitoring the water quality of the stream every month.

Based on Georgia Adopt-A-Stream

Breathtaking

BIOLOGICAL

Objectives: Students will describe the importance of dissolved oxygen (DO) to the survival of aquatic plants and animals by performing a controlled experiment with fertilizers, debris, and sediment.
Location: Indoors
Time Frame: 4 - 30 minute sessions over 2 weeks
Subject: Science, Ecology, Biology, and Chemistry
Level: 9th - 12th grade

Background:

Oxygen is important to the animals living in the water as it is to those living on land. Although oxygen does not dissolve very well in water, enough does to support a wide variety of living organisms. The solubility of oxygen in water depends on water temperature. Cool water can hold more oxygen than warmer water because gases are more soluble in cooler water. The amount of dissolved oxygen (DO) may vary significantly from one place to another and during times of the day in aquatic habitats for a variety of reasons. The highest concentration of DO occurs just at sunset. After sunset, plants respire (use oxygen). The lowest concentration of DO occurs at sunrise. This is the most likely time that a DO fish kill will occur. DO is in measured in parts per million (ppm). DO in aquatic environments can range from 0 to 15 ppm, but 6-10 ppm is sufficient for most aquatic animals.

Non-point sources of nutrient enrichment include fertilizers, livestock wastes, leaking septic tanks, and urban runoff. Phosphate detergents may enter water bodies in surface water runoff activities such as washing the car. Excessive nutrients entering a waterway can accelerate algae growth or cause an "algal bloom." Algal blooms can produce thick surface mats, turn the water green, stain boats, and may be toxic to animals that drink the water. When algae dies, oxygen is consumed by the decaying process which reduces the amount of oxygen remaining for use by aquatic animals.

Heavy rains can wash a variety of suspended materials into water bodies. Many other pollutants such as bacteria and harmful chemicals can also be transported on sediment. Sediment decreases light transmission thought the water, thus decreasing plant photosynthesis. In addition, livestock waste is another major non-point source pollutant. Wastes can be a major source of ammonia, a by-product of decomposition of fecal matter, uric acid, and urea. Additional information on non-point source pollution is in Appendices A-2 and B-1.

Materials:

10 one-quart wide-mouth jars
20 sample bottles
10 gallons of pond water

½ cup grass clippings

½ cup liquid fertilizer
½ cup topsoil from garden
10 measuring spoons
10 measuring cups
10 thermometers
10 turkey basters
Masking tape
Permanent ink pen
Dissolved oxygen kit or meter
Aluminum foil
Goggles
Gloves
Data chart
Optional: ½ cup manure (Make sure to wear gloves when handling animal waste)
Grow light
Note: Some of the equipment can be shared between groups

Preparation:

Order or borrow dissolved oxygen kits or meters. The day before the experiment, obtain top soil, manure, fertilizer and grass clippings. (ALWAYS handle any animal waste with gloves and wash hands afterwards.)

Collect the pond water the morning of the experiment. Water can be obtained from an aquarium. Follow standard safety procedures if students collect sample.

Procedures:

1. Explain that the amount of DO present in the water depends on the following: water temperature, amount of air mixed into the water as it moves, the amount of oxygen produced during photosynthesis by aquatic plants, the amount of oxygen used by plants and animals in respiration, and the amount of oxygen used by bacteria to decompose organic wastes.
2. Divide the class into groups of two or three and give each group a clean jar.
3. Using the chart included, assign one of the ten water samples to each team and have them prepare their samples as indicated.

Sample	Treatment
1 & 2	None; 3 cups pond water only
3 & 4	1/4 cup liquid household fertilizer in 3 cups water
5 & 6 (Optional)	1/4 cup manure in 3 cups water (Estimate)
7 & 8	1/4 cup grass clippings or leaf litter in 3 cups water
9 & 10	1/4 cup top soil or potting soil in 3 cup of water

4. Have the students swirl their samples (including controls) to stimulate the natural mixing of a body of water. Keep the pond/aquarium water sample to re-fill the jars on day 3 and 7.
5. Have the students label the jars.
6. Have the students measure and record the room and water temperature and the appearance of their samples on the data chart.
7. Place the uncapped jars in a sunny location near a window. A grow light can be used if a window isn't available.
8. Have the students record observations on their water samples daily for a course of 10 days. (You may wish to shorten the activity to five days. If you do, only add ½ cup of extra water on day 3 and demonstrate the DO test near the end of the 5-day period.)
   They are to answer the following questions on their chart:
   1. Is the water cloudy?
   2. Has the color changed?
   3. Is there more algal growth?
   4. Is a film forming on the surface?
9. On days 3 and 7, have the students add ½ cup of the extra aquarium water into the samples. Make sure the water is at room temperature.
10. Using the DO meter or kit, on the tenth day measure and record the DO of their water samples.
    (Use a turkey baster to transfer the water into the test bottle)
11. Compile all the class data on an overhead and discuss:
    a. DO levels in water can be reduced by non-point source pollutants.
    b. DO levels can be reduced when phosphates and nitrates from fertilizers are mixed with water.
    c. Bacteria which decompose organic material often actively compete with other oxygen-demanding organisms.

Evaluation:

1. Which samples had the highest DO?
2. Arrange the DO's of the samples from highest to lowest and discuss why you got these results.
3. Assuming the water was taken from a stream, what types of fish and macroinvertebrates would likely be present in each of the streams?
4. What are the most likely non-point sources of organic waste pollution in streams?

Extension:

1. Test DO upstream and downstream from a suspected non-point source of fertilizer or livestock waste.

   Does the DO content differ in these two areas? Why?

   What factors may be responsible for these differences?

   REMEMBER: Follow safety precautions.
2. Perform DO test as before on freshwater streams containing different sediment loads. Correlate DO with sediment loads and discuss the results with each student.

Based on the *Environmental Resource Guide,* *"Breathtaking".*

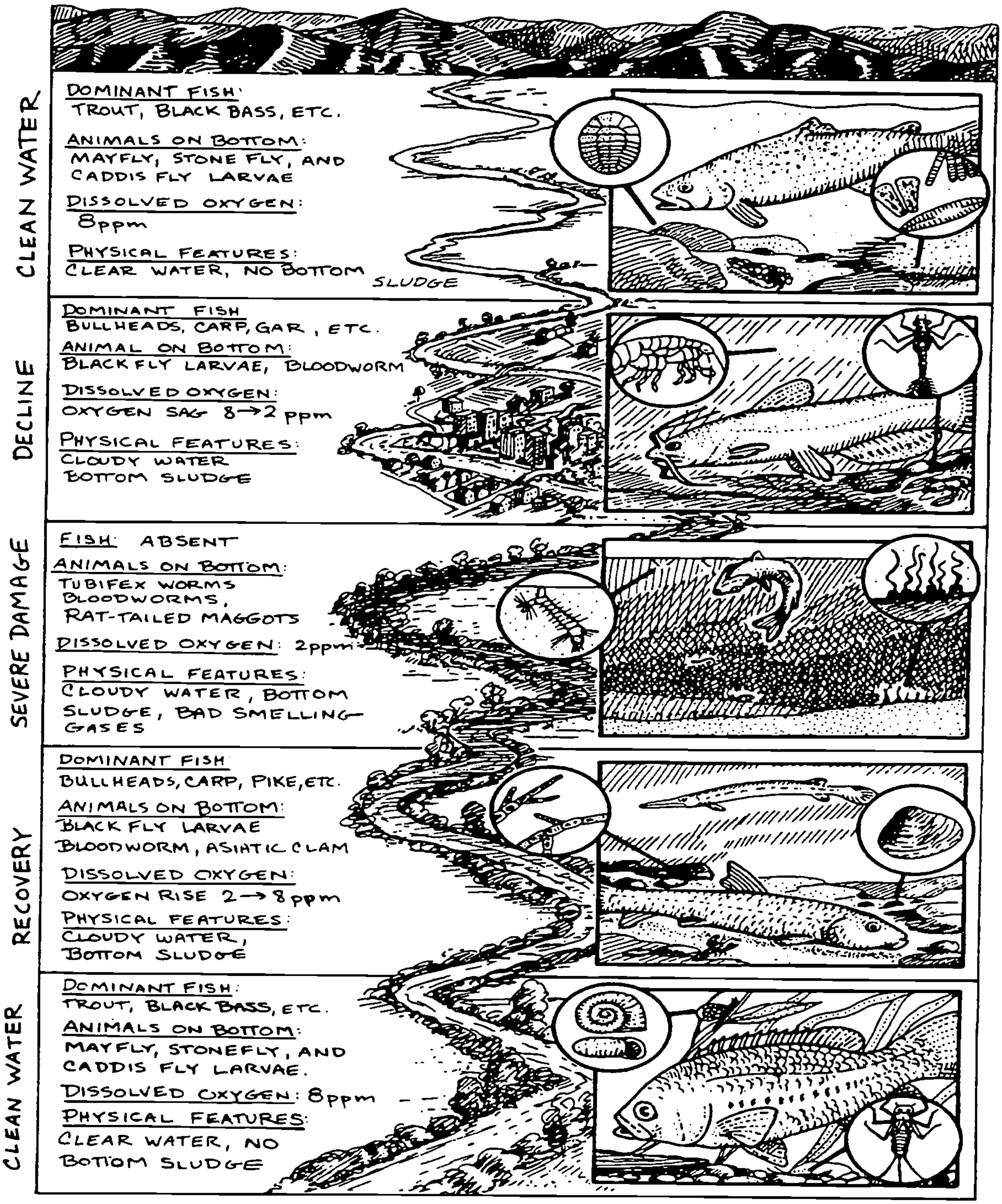
TABLE 1:
INDICATORS/EFFECT OF INORGANIC AND ORGANIC NUTRIENT POLLUTION ON OXYGEN LEVELS AND AQUATIC LIFE OF A STREAM

Amount of Pollution	Low	Medium	High
Dominant Fish	Gamefish: Trout, black bass, etc.	Non-game Fish: Bullheads, carp, gars, etc.	Fish Absent
Index Animals Present on River Bottom	Mayfly larvae Stonefly larvae Caddisfly larvae	Blackfly larvae Bloodworm	Sludge worms Bloodworms Rattailed maggots
Dissolved Oxygen (ppm)	> 8 ppm	4-8 ppm	2-4 ppm
Status of Water	Clean water	Decline	Severe damage, Decomposition
Physical Features	Clean water No bottom sludge	Cloudy water Bottom sludge	Cloudy water Bottom sludge Bad smelling gases

TABLE 2:
BIOLOGICAL OXYGEN DEMAND AND CORRESPONDING LEVELS OF ORGANIC WASTE POLLUTION

BOD (mg/l)	Indication of organic waste level
1-2	Very clean water, little organic waste
3-5	Moderately clean water, some organic waste
6-9	Polluted water, much organic waste and bacteria
10+	Very polluted

TABLE 3


CLEAN WATER
DOMINANT FISH:
TROUT, BLACK BASS, ETC.
ANIMALS ON BOTTOM:
MAYFLY, STONE FLY, AND CADDIS FLY LARVAE
DISSOLVED OXYGEN:
8ppm
PHYSICAL FEATURES:
CLEAR WATER, NO BOTTOM SLUDGE
DECLINE
DOMINANT FISH
BULLHEADS, CARP, GAR, ETC.
ANIMAL ON BOTTOM:
BLACK FLY LARVAE, BLOODWORM
DISSOLVED OXYGEN:
OXYGEN SAG 8→2 ppm
PHYSICAL FEATURES:
CLOUDY WATER
BOTTOM SLUDGE
SEVERE DAMAGE
FISH: ABSENT
ANIMALS ON BOTTOM:
TUBIFEX WORMS
BLOODWORMS,
RAT-TAILED MAGGOTS
DISSOLVED OXYGEN: 2ppm
PHYSICAL FEATURES:
CLOUDY WATER, BOTTOM SLUDGE, BAD SMELLING GASES
RECOVERY
DOMINANT FISH
BULLHEADS, CARP, PIKE, ETC.
ANIMALS ON BOTTOM:
BLACK FLY LARVAE
BLOODWORM, ASIATIC CLAM
DISSOLVED OXYGEN:
OXYGEN RISE 2→8 ppm
PHYSICAL FEATURES:
CLOUDY WATER,
BOTTOM SLUDGE
CLEAN WATER
DOMINANT FISH:
TROUT, BLACK BASS, ETC.
ANIMALS ON BOTTOM:
MAYFLY, STONEFLY, AND CADDIS FLY LARVAE.
DISSOLVED OXYGEN: 8ppm
PHYSICAL FEATURES:
CLEAR WATER, NO BOTTOM SLUDGE

DATA CHART

Name________________________________ Date (Day 1)__________

Sample #	Observations Day 1	Observations Day 3	Observations Day 7	Observations Day 10	DO		BOD
					Day 10	Day 15	
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							

Conclusions: ________________________________

Additional Reference Information

For additional information:

Activities Integrating Mathematics and Science
Water precious Water
P.O. Box 8120
Fresno, CA 93747-8120
(209) 255-4094

Air and Waste Management
Environmental Resource Guide
One Gateway Center, Third Floor
Pittsburgh, PA 15222
(412) 232-3444

Always A River
EPA
Form # AWBERC-91-09

Aquatic Project WILD
5430 Grosvenor Lane
Bethesda, MD 20814
(301) 493-5447

Rusty Garrison/ Georgia Widlife Resources Division
2425 Marben Farm Rd.
Mansfield, GA 30255
770-784-3059

Save Our Streams
Izaak Walton League of America
707 Conservation Lane
Gaithersburg, MD 20878-2983
(301) 548-0150

Appendix A-1
Fact Sheet- Watersheds

Watershed: Land area from which water drains to a particular water body

The total land area that contributes runoff to a specific body of water is called a watershed. Precipitation from rain and snow becomes either surface water runoff or groundwater. Any activities on the land that make up the watershed may impact the associated stream, river, lake, wetland. Sediment from new construction, forestry or agriculture, fertilizer from lawns and fields, gas and oil from parking lots may run over land to the nearest stream. Pollution reaching the stream from a these wide spread sources is called nonpoint source pollution. However, good preventive practices can stop most of this runoff from reaching the water.

A topographic map can be used to determine the boundaries of a watershed, identify some land use practices, and plan best management programs to prevent or reduce pollution.

Map scale is the relationship of distance on a map to the actual distance on the ground. Scale is expressed as a ration and is graphically represented by a bar scale. For example, 1:24,000 means that one inch on the map is equivalent to 24,000 inches of the actual area. This value is not quite half a mile.

Colors are used to indicate particular features on a topographic map. Cultural or human-made features are black. Water is blue and vegetation is green. Red indicates roads. Brown is used for contour lines indicating changes in elevation. In addition, symbols represent surface features. For example, a house is indicated by a black box.

Topographic maps show the shape of the earth's surface using contour lines. Contour lines are imaginary lines that trace the land's surface at a particular elevation. Elevation is important in analyzing water flow patterns. Intervals between contour lines are indicated on the map scale. A typical interval is 20 feet. In steep areas, the contour lines appear close together and on flat areas the contour lines are far apart.

Concentric circles or ovals indicate a knob or hill. Contour lines and elevation changes are helpful in establishing watershed boundaries. By marking the hilltops and ridges, it's possible to create a good outline of the complete watershed because water flows downhill, perpendicular to contours.

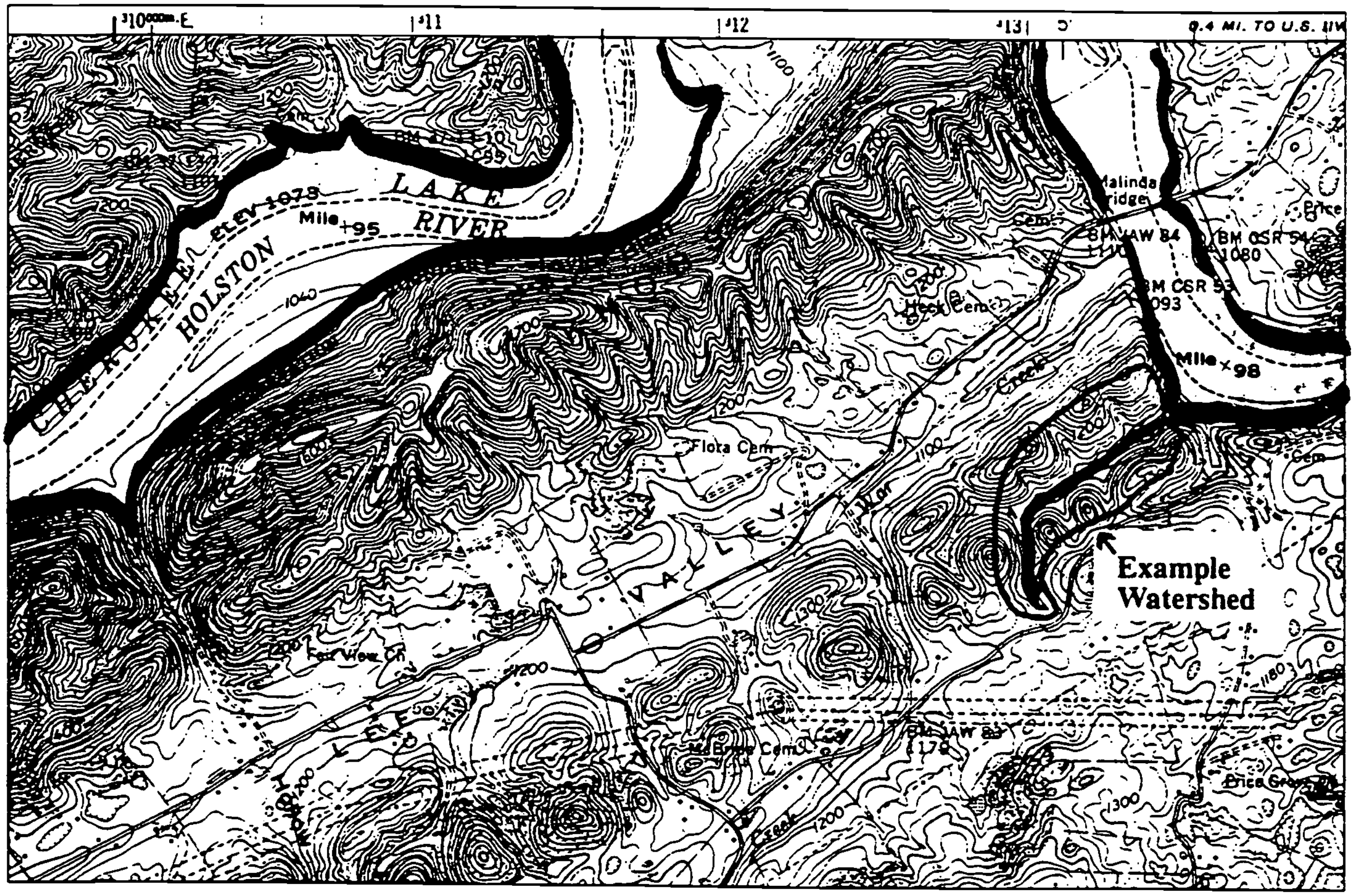
To outline a watershed, follow these steps:

1. Find a 1st order stream (a small stream with no other streams joining it) on the topographic map. Mark the stream by highlighting it with a colored pencil.
2. Find the brown lines drawn next to the stream. Some of the lines will have numbers. These are contour lines and the numbers represent the elevation of the land. Most contour lines mark a 20 foot change in

elevation (unless otherwise noted).

3. Place your pencil on the stream, choose one direction to move that is perpendicular to the stream flow (for example, if the stream flows east-west, choose to move north or south). Continue moving on the contour lines perpendicular to the stream until the elevation stops increasing. This marks the watershed boundary. Place a "X" at the boundary. HINT- Any circular contour lines represent a hill. The middle of the circle is the peak of the hill. This often is a boundary line of a watershed. Place a "X" here.
4. Go back to the stream and find the edge of the watershed in the opposite direction following step #3. Place a mark here.
5. Continue moving upstream and downstream making dots to mark the boundary of the watershed. You will know soon outline the complete area of land that drains to your highlighted stream. See the attached example.
6. For 2nd order streams or rivers, highlight the entire water section first, then follow the above steps.

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY



Appendix A-2
Fact Sheet - Land Uses and Water Quality

Urbanization

The urbanization of land concentrates people, and the pollutants that result from their lifestyles, in areas that largely covered with impervious surfaces--buildings, driveways, roads, sidewalks, and parking lots. This combination of people, pollutants, and pavement produces urban runoff that can carry a greater pollutant load than municipal sewage.

The amount of pollutants carried in urban runoff with stormwater or snowmelt is influences by traffic density, littering, fertilizer and pesticide use, construction site practices, animal wastes, soil characteristics, topography of the area, percentage of impervious surfaces, atmospheric deposition, and amount of precipitation.

Pollutants transported in urban storm sewer systems to nearby waters include nutrients, bacteria, litter soil, toxic chemicals, and organic (oxygen-consuming) materials.

Construction sites

Construction activities can harm nearby waters in three ways. The first occurs when natural land cover is disturbed during excavation and grading operations. Soil stripped of its protective vegetation can be easily washed into nearby surface waters.

Second, stormwater runoff often carries materials used on the site, such as oil, grease, paints, glues preservatives, acids, cleaning solutions, and solvents, into nearby lakes or streams.

And third, inadequate planning--failure to design and construct projects with water quality factors in mind, such as peak runoff and flow routing--can accelerate runoff.

Septic Systems

Many homes are not connected to municipal wastewater treatment systems and rely on septic tanks and field lines for sewage treatment.

If they are well designed, installed, and maintained, septic systems will safely treat wastewater for 20 to 50 years. Improper design, installation, or operation of septic systems or holding tanks can lead to pollution of surface or groundwater by bacteria, nutrients, and household toxic chemicals. A recent U.S. Environmental Protection Agency (EPA) report stated that most waterborne diseases are probably caused by old or poorly designed and operated septic systems.

Septic systems use natural decomposition to treat wastes. Holding tanks do not treat wastes, but simply contain them on site. Both septic systems and holding tanks must be periodically pumped out or cleaned. Care must be taken in disposing of the materials removed in this cleaning. Solids cleaned out of septic systems can be land-spread since they are partially treated, but continuous spreading on a single site of land should be avoided. Wastes removed from holding tanks need additional treatment since they generally have not undergone much decomposition.

Deicing Materials

Keeping roads safe in the winter requires the use of deicing materials, but the stockpiling and application of these materials (primarily sand and salt) can harm surface and groundwater.

Runoff from inadequately protected stockpiles of salt or sand and salt mixtures has contaminated both surface and groundwater. One study estimated that if all stockpiles were covered, most of the reported cost of the environment from the use of deicing materials would be eliminated.

Frequent or highly concentrated road salt application can cause surface water quality problems, particularly in small lakes or streams. Shallow groundwater contamination may be caused by the use of deicing materials, particularly in areas of sandy soils or karst topography (where there are direct connections, such as sinkholes, between surface and groundwater).

Croplands

Stormwater and snowmelt runoff from croplands can carry sediments, nutrients, bacteria, and organic contaminants into nearby lakes and streams. Nitrates and pesticides can seep from agricultural lands and contaminate underlying groundwater supplies.

By volume, sediment is the pollutant entering waters in the largest quantity. Cropland erosion is the most significant source of sediment.

Good water quality and soil erosion management practices by individual land managers is the key to stopping valuable soil loss. This also protects water quality by preventing the movement of sediment and other pollutants from croplands to waters.

Livestock Operations

Animal feedlots are defined as lots and buildings used to confine animals for feeding, breeding, raising, or holding purposes. This definition includes open ranges used for feeding and raising poultry, but does not include pastures.

Poor or inadequate feedlot management can allow stormwater runoff to carry pollutants from accumulating manure into surface and groundwaters.

The trend nationally has been toward the construction and operation of fewer, but larger and more specialized livestock and poultry farms.

Feedlots can create significant pollution problems. Pollutants coming from animal feedlots include nutrients, oxygen-demanding materials, and pathogens that may affect humans and animals. High nitrate levels in groundwater have been associated with improper storage of animal manure.

Fertilizers

Nitrogen, phosphorus, and potassium are the three primary nutrients applied to crops, gardens, and lawns as fertilizers.

Phosphorus and nitrogen entering water bodies in runoff from overfertilized areas can cause nuisance conditions, such as heavy algal blooms and excessive weed growth, making lakes unsuitable for swimming, waterskiing, and other uses.

The presence of nitrates in rural well water presents a risk to infants under six months old whose formula is prepared with nitrate-contaminated water. Young infants lack

the ability to handle high levels of nitrate and may develop methemoglobinemia (blue-baby syndrome), a disease impairing the ability of blood to carry oxygen throughout the body.

Studies have indicated that nitrogen in fertilizers and manures is a probable source of elevated nitrate concentrations in rural groundwater supplies.

Pesticides

Pesticides are used to control undesirable plants or animals. They include herbicides, insecticides, fungicides, and rodenticide. Pesticides are used on agricultural lands, on urban and suburban lawns and gardens, as aquatic nuisance controls in lakes, and in forest management.

Pesticide application can lead to groundwater contamination. Surface waters can be contaminated by drift from pesticide spraying and by runoff from pesticide-treated soil. Both surface and groundwaters are vulnerable to contamination by stormwater runoff flowing from storage, mixing, loading, and spray-tank cleaning areas.

Mining Activities

Mining activities can cause dramatic changes in surrounding watersheds. Lakes, streams, and groundwater can be polluted by sediment, tailings, dust, chemicals, and wastes from open pit, strip, and underground mines.

Regulations to control mining activities have been instituted at both U.S. Federal and state levels. The National Pollutant Discharge Elimination System (NPDES) permit program administered by state agencies regulates discharges from industries into state waters and is used as a tool to regulate pollution from mining.

Forest Practices

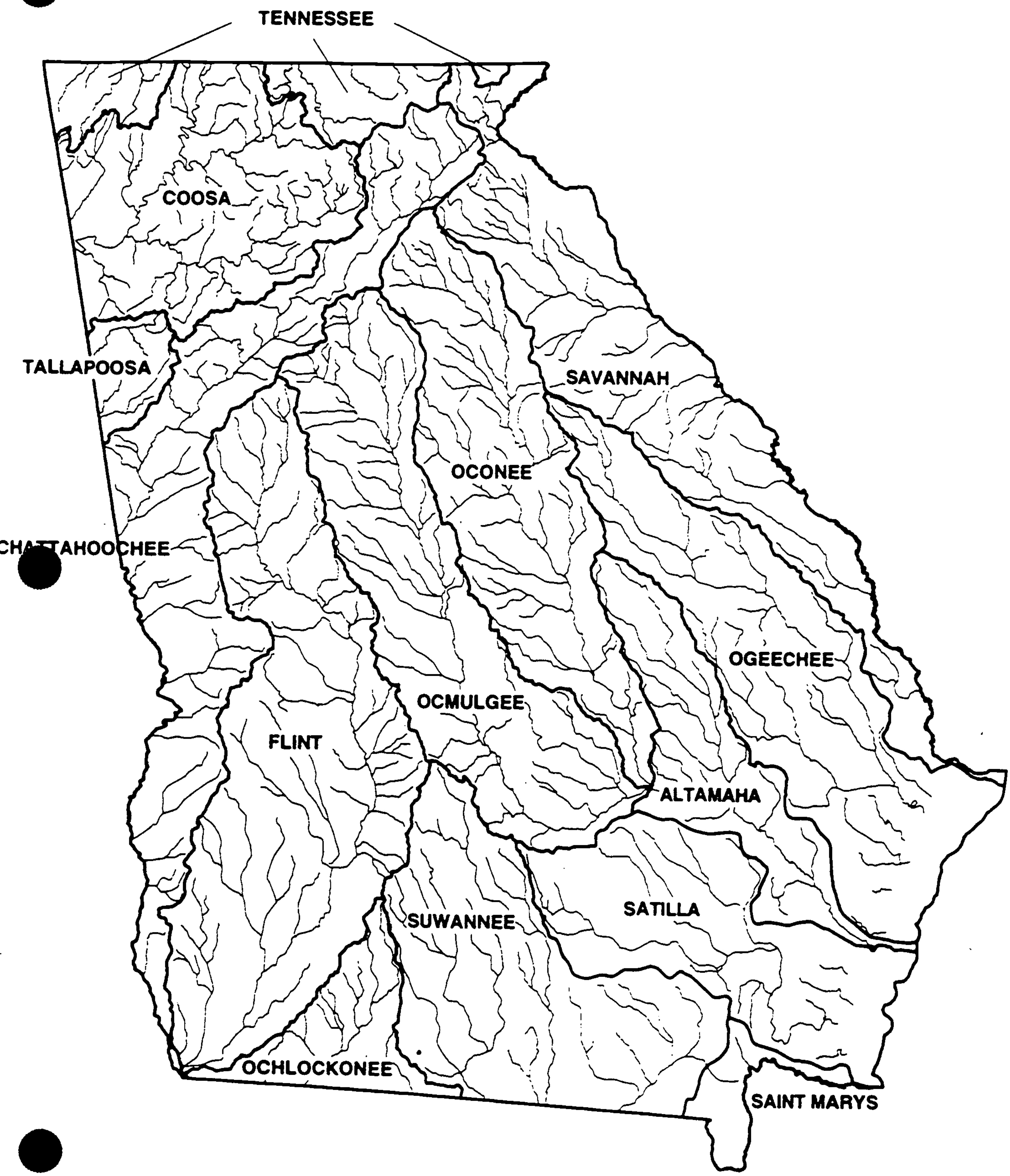
Waters in forested areas usually are of very high quality, so pollution, when it does occur, is likely to harm a valuable and relatively sensitive ecosystem.

Forestry activities that can transfer pollutants from land to water are road construction, clearing land for fire breaks, stacking and loading operations during harvest, mechanical site preparation, controlled burning for site preparation, and application of pesticides and herbicides.

Many large forested areas are managed by the U.S. Forest Service and state agencies. These agencies have authority to protect water quality by regulating forestry practices on public lands. Establishing effective forest management practices on private land is the primary concern for continued water quality protection from forestry activities.

SOURCE: Tennessee Valley Authority, Teacher/Student Water quality Monitoring Network Fall Workshop Teacher Guide, TVA, Norris, Tennessee, 1992.

Appendix A-3
Major Watersheds of Georgia



Appendix A-5
Visual Survey / Watershed Walk

GEORGIA ADOPT-A-STREAM
WATERSHED WALK SURVEY FORM

Department of Natural Resources
Environmental Protection Division

Stream Name ______________________ Date ______________________

Stream Segment. Include a map with starting and ending points: a road crossing, a county park, another stream.

____

Group Leader ______________________ Phone ______________________

Participants ____

____

Date of last rainfall ______________________ Water flow ☐ high ☐ normal ☐ low

Weather conditions ______________________ Air temperature ______________

AFTER THE WATERSHED WALK: SUMMARY

In each of the five areas listed below, comment on:

1. Overall conditions,
2. Any conditions that warrant particular attention, or
3. Any conditions in which you noticed a major change along the length of your segment.

LAND USE ____

BANK CONDITIONS ____

WATER AND WATER SURFACE ____

STREAM BED ____

HUMAN IMPACTS ____

OVERALL ASSESSMENT (from scale on back): ______________________________

☐ EXCELLENT ☐ GOOD/FAIR ☐ POOR

WATERSHED WALK SURVEY

Check the column that best describes your stream segment for each category. Consider the area within 1/4 mile o your stream segment as the watershed for ranking purposes.

	POOR	FAIR/GOOD	EXCELLENT
LAND USE BY THE STREAM	BARE DIRTor COMPLETELY PAVED MAXIMUM DISTURBANCE	LITTLE to MODERATE COVER, SOME BARE GROUND AND SOME PAVED	UNDISTURBED, GOOD COVER ALL YEAR
BANKS erosion	SEVERE EROSION exposed dirt obvious loss of soil, steep slope	MODERATE EROSION some exposed dirt and some cover, slight evidence of soil loss, gentle slope	NO EROSION dirt is covered no evidence of soil loss
BANKS vegetation	LITTLE OR NO VEGETATION exposed dirt	MODERATE VEGETATION problems at high flow times	GOOD VEGETATION COVER
WATER SURFACE	FILM OR FOAM IS PRONOUNCED	SLIGHT FILM OR FOAM	NO SLICK OR FILM OR FOAM
WATER COLOR/CLARITY	HIGHLY COLORED OR LOW CLARITY	LITTLE COLOR OR SLIGHT LOSS OF CLARITY	CLEAR WATER
WATER ODOR	SEVERE ODOR	SLIGHT ODOR	NO ODOR
STREAM BED SILTATION	MUCH SILT shows erosion	SLIGHT SILT some erosion	NO SILT no erosion
ALGAL GROWTH IN STREAM	OVERABUNDANT ALGAL GROWTH	NO ALGAE	MODERATE ALGAL GROWTH
ANIMAL LIFE (fish/frog)	NONE	FEW	ABUNDANT
BACTERIA IRON IN STREAM BED	OVER ABUNDANT	MODERATE	NONE
LITTER	VERY COMMON	SMALL AMOUNT	NONE
HUMAN IMPACTS IN STREAM	MAJOR (dams, pipes, road culverts, etc)	MODERATE some evidence of change	LITTLE seems natural

GEORGIA ADOPT-A-STREAM

Visual Survey

Use this form to record important information about the health of your stream. By keeping accurate and consistent records of your visual observations, you can document current conditions and changes in water quality and habitat.

Name of Stream Location

Individual or group Members present

Date County

Weather conditions
☐ clear ☐ cloudy ☐ rain ☐ rain within last 24 to 48 hours?

VISUAL SURVEY

Water flow ☐ high ☐ normal ☐ low ☐ measured _______cfs
Number of pools________ Number of riffles_______ Stream Width_______ ft. Stream Depth_______ ft.

Water appearance:

☐ clear
☐ muddy
☐ oily
☐ foamy
☐ scum
☐ milky/gray
☐ green
☐ brown
☐ black
☐ other__________

Odor:

☐ none
☐ natural
☐ gasoline or oil
☐ chlorine
☐ rotten egg
☐ sewage
☐ chemical
☐ other____________

Habitat Description (Use chart on back)	Excellent	Good	Fair	Poor
Stream Bed	☐	☐	☐	☐
Sediment Depsosits	☐	☐	☐	☐
Streambank Stability	☐	☐	☐	☐
Streambank Cover	☐	☐	☐	☐

Algae appearance:
☐ light green
☐ dark green
☐ brown coated
☐ matted on stream bed
☐ hairy
☐ floating

Algae located:
☐ not present
☐ in spots
☐ attached
☐ everywhere

☐ Other observations? Wildlife?________________________________

☐ Evidence of pollution? How much/what kind?________________________________

☐ Litter or trash in area? How much/what kind?________________________________

· *Based in part on the Izaak Walton League of America, SOS Program*

Habitat Description	Excellent	Good	Fair	Poor
Stream Bed	More than 50% rocks, logs, vegetation, undercut banks or other stable habitat.	50% to 30% rocks, logs, vegetation, or undercut banks. Adequate habitat for fish and aquatic insects.	30% to 10% rocks, logs, vegetation, or undercut banks. Less than desirable habitat for fish and aquatic insects.	Less than 10% rocks, logs, vegetation, or undercut banks. Obvious lack of habitat for fish and aquatic insects.
Sediment Deposits	Little or no sediment deposits. Less than 5% of stream bed has sediment.	Some sediment deposits, mostly in pools. 5% to 30% of stream bed has sediment.	Moderate sediment deposits. 30% to 50% of stream bed has sediment.	Heavy deposits of sediment. More than 50% of stream bed has sediment.
Streambank Stability	Stable. No evidence of erosion.	Moderately stable. Only small areas of erosion.	Moderately unstable. Up to 60% of banks have evidence of erosion.	Unstable. 60% to 100% of banks have evidence of erosion.
Streambank Cover	More than 80% of streambank covered with vegetation, rocks and other stable material.	80% to 50% of streambank covered with vegetation, rocks and other stable material.	50% to 25% of streambank covered with vegetation, rocks and other stable material.	Less than 25% of streambank covered with vegetation, rocks and other stable material.

Appendix B-1
Fact Sheet - Non-point Source Pollution

Water pollution is any human-caused contamination of water that reduces its usefulness to humans and other organisms in the water. Water pollution can be divided into two classes. Point source pollution is contamination that comes from a single, clearly identifiable source, such as a pipe which discharges material from a factory into a lake, stream, or river. Non-point source pollution originates over a broad area from a variety of causes. Non-point source pollution is more difficult to identify than point source pollution. Examples of non-point source pollution include; animal wastes from agriculture, sediment from construction and logging, and petroleum-based products from streets and parking lots.

SEDIMENTS

Particles of soils, sand, silt, clay and minerals wash from land and paved areas into creeks and tributaries. In large unnatural quantities, these natural materials can be considered a pollutant. Construction projects often contribute large amounts of sediment. Certain lumbering practices affect sediments in runoff. Sediments may fill stream channels and harbors that later require dredging. Sediments suffocate fish and shellfish populations by covering fish nests and clogging the grills of bottom fish and shellfish. It can be point source or non-point source pollution. Sediment in water can also create thermal pollution problems. Sediment darkens water which causes it to absorb more solar radiation. This raises water temperatures to the point where it may not support some forms of life. At the same time, sediment blocks light from reaching aquatic plant life, slowing or stopping plant growth. Also, warmer water cannot hold as much dissolved oxygen. If fact, oxygen levels can be reduced to the point that fish kills occur.

NUTRIENTS

Nutrients like phosphates and nitrates stimulate plant growth and are primary ingredients in fertilizers. Theses compounds occur naturally. In fact, certain levels of nutrients are necessary to maintain healthy aquatic ecosystems. But in excess quantities they can cause great damage. Approximately 80 percent of nitrates and 75 percent of phosphates introduced to lakes and streams min the U.S. are the result of human activities.

Sources of nutrient pollution are sewage and septic runoff, livestock wastes, fertilizer runoff, detergents, and industrial wastes. Some of these are point sources, while others are non-point sources. When soluble inorganic nitrogen concentration in water reach just 0.3 ppm and inorganic phosphorous concentration reach 0.01 ppm, algae "blooms" or multiplies rapidly. An algae bloom can become so severe that an entire lake can be covered with green, foul-smelling mats of algae.

Algal blooms can harm aquatic life and impair water quality. Algae, like all plants, requires oxygen for respiration and growth. When algae multiply rapidly, the larger

population requires more oxygen , which can deplete the supply for other aquatic life. This can cause other organisms to suffocate. For example, it is not uncommon for fish kills to occur at night when algae are using oxygen to respire and growth instead of producing it though photosynthesis.

Eutrophication is a process where lakes and other water bodies accumulate decaying plant materials and sediment and begin to shrink in size. The addition of nutrients to a lake or other waterway which causes plant growth and subsequently causes eutrophication is a naturally occurring process. This happens slowly over millions of years. When the process is accelerated by the addition of excess nutrients, it can reduce the usefulness of the waterbody for recreation and water supply.

PETROLEUM PRODUCTS

Oil and other petroleum products like gasoline and kerosene can find their way into water from ships, oil drilling rigs, oil refineries, automobile service stations and streets. Oil spills kill aquatic life (fish, birds, shellfish and vegetation). Birds are unable to fly when oil loads the feathers. Shellfish and small fish are poisoned. If petroleum products are washed on the beach, it is expensive and time consuming to clean up. Fuel oil, gasoline and kerosene may leak into ground water through damaged underground storage tanks.

ANIMAL WASTE

Human wastes that are not properly treated at a wastewater treatment plant may contain harmful bacteria and viruses. Typhoid fever, polio, cholera, dysentery (diarrhea), hepatitis, flu and common cold germs are examples of diseases caused by bacteria and viruses in contaminated water. People can come into contact with these microorganisms by drinking the polluted water or through swimming, fishing, or eating shellfish in polluted waters. Often unexpected flooding of barnyards or stock pens can suddenly increase the toxic effects of animal waste in water. Animal waste can also act as a fertilizer and create damage by increasing nutrients. (see Fertilizers)

ORGANIC WASTES

Domestic sewage treatment plants, food processing plants, paper mill plants and leather tanning factories release organic wastes into waterways that bacteria consume. If too much waste is released, the bacterial populations increase and use up the oxygen in the water.

INORGANIC CHEMICALS

Inorganic chemicals and mineral substances, solid matter and metal salts commonly dissolve in water. These chemicals often come from mining and manufacturing industries, oil field operations, agriculture, and natural sources. These chemicals interfere with natural stream purification, and can be harmful to fish and other aquatic life. They also corrode expensive water treatment equipment and increase the cost of boat maintenance.

DETERGENTS AND FERTILIZERS

Many detergents and fertilizers are toxic to fish and harmful to humans. They cause taste and odor problems in drinking water and often cannot be treated effectively. Some

are very poisonous at low concentrations.

HEATED OR COOLED WATER

Heat reduces the ability of water dissolved oxygen. Electric power plants use large quantities of water in their steam turbines. The heated water is often returned to streams, lagoons, or reservoirs. With less oxygen in the water, fish and other aquatic life can be harmed. Deep dams often let extra water flow downstream. When the water comes from the bottom of the dam, it is much colder than normal.

ACID PRECIPITATION

Aquatic animals and plants are adjusted to a rather narrow range of pH levels. pH is a measure of the acidity or alkalinity of a solution. When water becomes too acid or basic, sensitive fish and other organisms cannot survive.

PESTICIDES, HERBICIDES, FUNGICIDES

Agricultural chemicals designed to kill or limit the growth of weeds, fungus and insects are a common form of nonpoint source pollution. This pollution results from attempts to limit the negative effects of undesirable species on crops, fields or lawns. Irrigation, groundwater flow and natural runoff brings these toxic substances to rivers, streams, lakes and oceans. Buffers of vegetation next to streams control most overland runoff.

Appendix B-2
Fact Sheet - Non-point Source Pollution Solutions

URBAN AND SUBURBAN
Urban runoff is still controlled primarily by voluntary means, but cities have adopted new practices like leaf collection and street cleaning at critical times, that can reduce the flow of sediment and other contaminants into waterways. Detention-retention ponds have been incorporated into some water control systems to allow contaminants to settle, and to feed rainwater into runoff channels a at a controlled rate.

CONSTRUCTION
Construction must take into account both short-term and long-term water pollution management practices. Construction removes vegetation from the ground, inviting erosion and sediment pollution. Practices to reduce this include temporary measures such as diverting water flow through trenches or sediment ponds that allow silt and other materials to settle before water runs off into streams. Silt screens, hay bales, mulch, and other materials may also be used as temporary controls, as well as the planting of temporary grasses to control erosion before more permanent landscaping can be done.

CROPLANDS
One practice for reducing erosion and sediment pollution is conservation tillage. Instead of plowing under the residue from a previous crop and exposing bare soil, conservation tillage uses a disc or other device to cut thought the residue so seeds can be planted, This process allows a protective layer of vegetation to remain on top of the soil to retard erosion and to retain more water in the soil. Agricultural extension services provide soil testing to determine the need for fertilizers. The tests will indicate which nutrients may be needed for the type of soil so over-fertilization does not occur. Buffers of vegetation next to a stream also prevents most overland runoff.

FEEDLOTS/CHICKEN HOUSES
A waste management system must have three basic components: collection, transportation, and storage or disposal of animal wastes. Many facilities have storage ponds that treat wastes before discharging into waters. Chicken houses will often sell their wastes for fertilizer on fields.

FORESTS
Many logging companies use selective cutting practices that allow for better timber choices and minimal impact on the land. Logging roads may wind around hills to reduce erosion and allow natural growth to quickly “retake’ the land after cutting is finished. A “buffer zone”, area of timber let at the stream banks, can be left. The remaining trees reduce the amount of erosion reaching the stream and the trees cover the stream leaving the water temperature normal.

Appendix C-1
Fact Sheet - More about Aquatic Insects

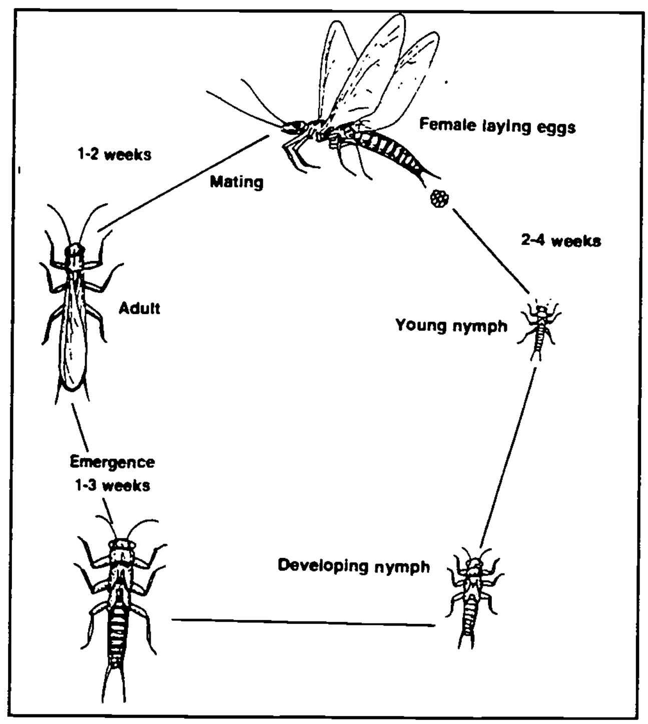
To understand and identify aquatic insects, one must start with how all animals are classified. The most general category is first, with the species level being the most specific. Volunteers will learn to identify aquatic insects to the order level. A stonefly is classified as an example.

Kingdom	Animal (all animals)
Phylum	Arthropoda
Class	Insecta (all insects)
Order	Plecoptera (all stoneflies)
Family, Genus, and Species	Perlidae (Golden Stonefly)

Life Stages of Insects

Identifying insects is complicated because of the different stages they pass through during their development. The changes that occur from the egg stage to the adult are often dramatic. The incredible change of a caterpillar into a butterfly is well known. Most aquatic insects experience similar changes. The process of changing form during the life cycle is called metamorphosis. Three types of metamorphosis are possible: ametabolous, incomplete, and complete.

Ametabolous Metamorphosis. This type of metamorphosis means without change and refers to the lack of change between the immature and adult stages. It's found only in a few very primitive orders of insects that have no wings as adults. Some species are semiaquatic.

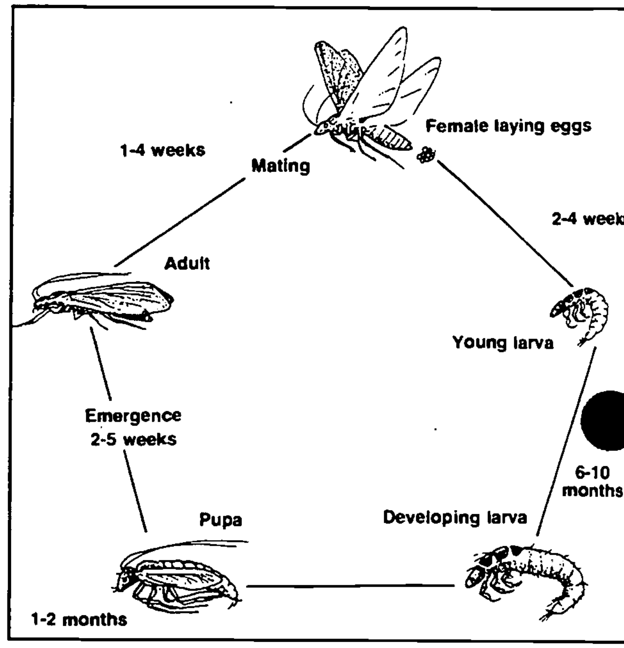


Incomplete Metamorphosis. Insects with incomplete metamorphosis pass through three distinct stages: egg, nymph, and adult. The time required to complete each stage varies widely. Normally the greatest amount of time is spent in the nymphal stage. In most cases, the entire cycle requires one year to complete, although this also varies with different species. Nymphs often look similar to their adult stage. As nymphs mature, the adult wings begin developing in stiff pouch-like structures on the thorax called wing pads. This is an obvious and unique characteristic of insects with

incomplete metamorphosis. The wing pads on fully mature nymphs will be quite dark, almost black, in color. The orders of aquatic insects with incomplete metamorphosis include:

Mayflies (Order Ephemeroptera)
Dragonflies and Damselfies (Order Odonata)
Stoneflies (Order Plecoptera)
Water Bugs (Order Hemiptera)

Complete Metamorphosis. Insects with complete metamorphosis pass through four distinct stages: egg, larva, pupa, and adult. The addition of the pupal stage separates insects with complete metamorphosis from those with incomplete metamorphosis. While the length of time needed to complete each stage again varies widely, the entire cycle usually takes one year. Most of the cycle is generally spent in the larval stage. Unlike nymphs, larvae bear little resemblance to the adults and show no development of wing pads. It is during the pupal stage that the wing pads and other adult features develop. The orders of aquatic insects



Dobsonflies and Alderflies (Order Megaloptera)
Caddisflies (Order Trichoptera)
Aquatic Moths (Order Lepidoptera)
Aquatic Flies (Order Diptera)
Aquatic Beetles (Order Coleoptera)

Growth and Development

The growth of insects occurs in a series of stages called **instars**. The exoskeleton of insects must be periodically shed in order for growth to continue. The process of shedding the old exoskeleton is called **molting**. When the old exoskeleton is cast aside, a new, slightly larger one is present underneath. The old empty exoskeleton is often referred to as a **shuck**. Except for mayflies, molting stops once the insect reaches the winged adult stage. Most insects molt five or six times during their development. Mayflies, stoneflies, dragonflies, and damselfies, however, may molt 15-30 times before reaching their adult stage.

Recognizing the insects's stage and degree of development can help the angler determine what insect to imitate. Mature nymphs and larvae often become more active in the water as they move to emergence or pupation sites. This increased activity

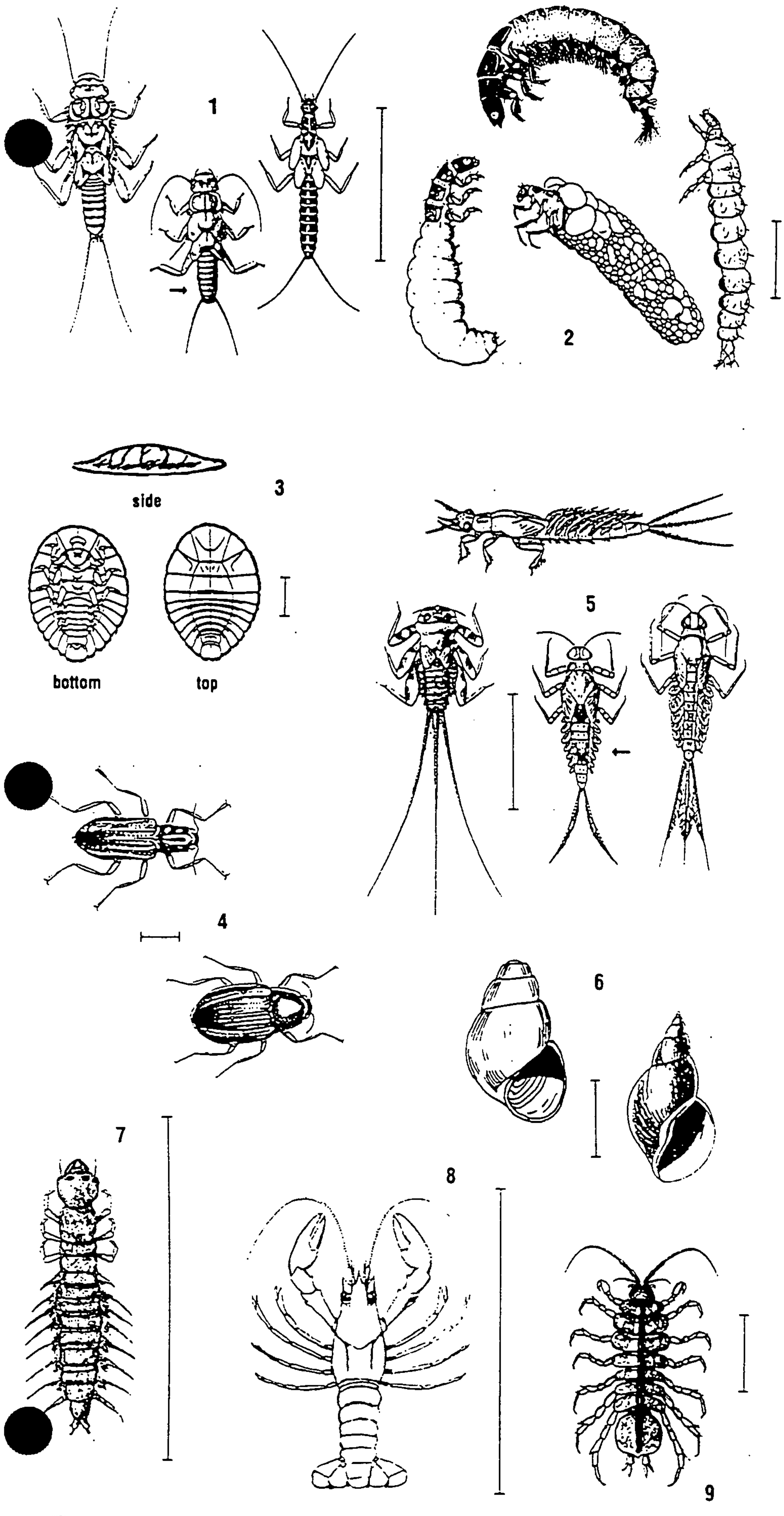
makes them more available to fish and , thus, makes them more important to imitate. Looking for and imitating the most mature insects will normally produce the best fishing.

One of the most vulnerable periods in the insect's life cycle is during emergence from immature to the adult stage. At the time of emergence, mature nymphs or pupae typically crawl out of the water or swim to the water's surface. Those that emerge in the surface film must break through the surface tension, and that can take from several seconds to over a minute. Thus during emergence, the insects are no longer protected by the shelter of the lake of stream bottom. Fish readily take advantage of the insects' vulnerability and often feed selectively on emerging nymphs or pupae. The angler who recognizes this activity will find fast fishing by imitating the shape and action of the natural.

Adult insects often rest on the water's surface after emerging from the nymphal or pupal shuck. Then, after mating, most aquatic insects return to the water to lay their eggs. Insects resting or laying eggs on the surface provide fish with many easy meals.

Source: An Angler's Guide to Aquatic Insects and their Imitations, Hafele and Roederer, 1987.

Stream Insects & Crustaceans



Bar lines indicate relative size

GROUP ONE TAXA

Pollution sensitive organisms found in good quality water.

1 *Stonefly: Order Plecoptera.* 1/2" - 1 1/2", 6 legs with hooked tips, antennae, 2 hair-like tails. Smooth (no gills) on lower half of body. (See arrow.)

2 *Caddisfly: Order Trichoptera.* Up to 1", 6 hooked legs on upper third of body, 2 hooks at back end. May be in a stick, rock or leaf case with its head sticking out. May have fluffy gill tufts on lower half.

3 *Water Penny: Order Coleoptera.* 1/4", flat saucer-shaped body with a raised bump on one side and 6 tiny legs on the other side. Immature beetle.

4 *Riffle Beetle: Order Coleoptera.* 1/4", oval body covered with tiny hairs, 6 legs, antennae. Walks slowly underwater. Does not swim on surface.

5 *Mayfly: Order Ephemeroptera.* 1/4" - 1", brown, moving, plate-like or feathery gills on sides of lower body (see arrow), 6 large hooked legs, antennae, 2 or 3 long, hair-like tails. Tails may be webbed together.

6 *Gilled Snail: Class Gastropoda.* Shell opening covered by thin plate called operculum. Shell usually opens on right.

7 *Dobsonfly (Hellgrammite): Family Corydalidae.* 3/4" - 4", dark-colored, 6 legs, large pinching jaws, eight pairs feelers on lower half of body with paired cotton-like gill tufts along underside, short antennae, 2 tails and 2 pairs of hooks at back end.

GROUP TWO TAXA

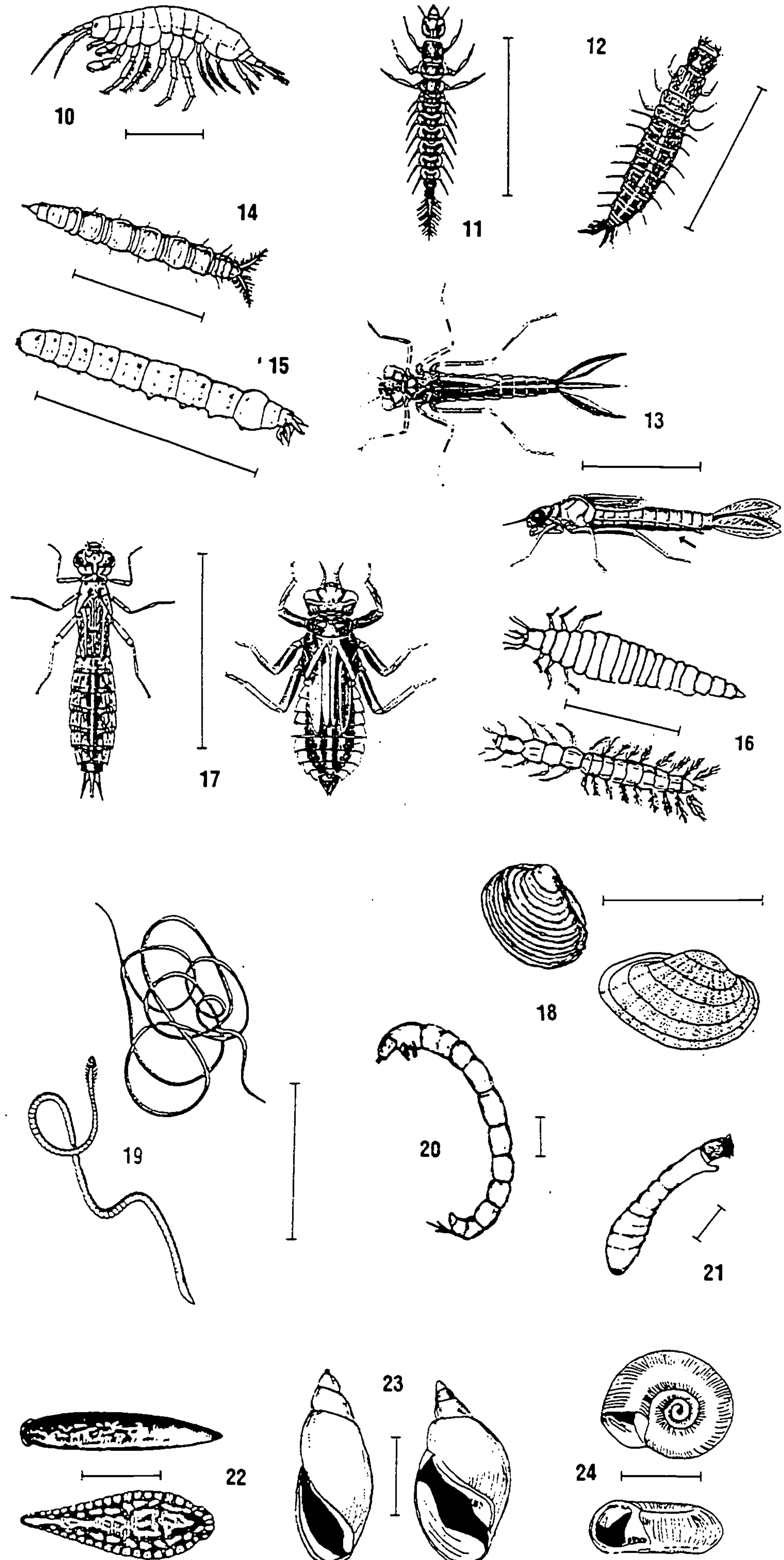
Somewhat pollution tolerant organisms can be in good or fair quality water.

8 *Crayfish: Order Decapoda.* Up to 6", 2 large claws, 8 legs, resembles small lobster.

9 *Sowbug: Order Isopoda.* 1/4" - 3/4", gray oblong body wider than it is high, more than 6 legs, long antennae.

Save Our Streams

Izaak Walton League of America
1401 Wilson Blvd. Level B
Arlington, VA 22209



Bar lines indicate relative size

GROUP TWO TAXA continued

10 *Scud: Order Amphipoda.* 1/4", white to grey, body higher than it is wide, swims sideways, more than 6 legs, resembles small shrimp.

11 *Alderfly larva: Family Sialidae.* 1" long. Looks like small hellgrammite but has 1 long, thin, branched tail at back end (no hooks). No gill tufts underneath.

12 *Fishfly larva: Family Corydalidae.* Up to 1 1/2" long. Looks like small hellgrammite but often a lighter reddish-tan color, or with yellowish streaks. No gill tufts underneath.

13 *Damselfly: Suborder Zygoptera.* 1/2" - 1", large eyes, 6 thin hooked legs, 3 broad oar-shaped tails, positioned like a tripod. Smooth (no gills) on sides of lower half of body. (See arrow.)

14 *Watersnipe Fly Larva: Family Athericidae (Atherix).* 1/4" - 1", pale to green, tapered body, many caterpillar-like legs, conical head, feathery "horns" at back end.

15 *Crane Fly: Suborder Nematocera.* 1/3" -2", milky, green, or light brown, plump caterpillar-like segmented body, 4 finger-like lobes at back end.

16 *Beetle Larva: Order Coleoptera.* 1/4" 1", light-colored, 6 legs on upper half of body, feelers, antennae.

17 *Dragon Fly: Suborder Anisoptera.* 1/2" - 2", large eyes, 6 hooked legs. Wide oval to round abdomen.

18 *Clam: Class Bivalvia.*

GROUP THREE TAXA

Pollution tolerant organisms can be in any quality of water.

19 *Aquatic Worm: Class Oligochaeta.* 1/4" - 2", can be very tiny; thin worm- like body.

20 *Midge Fly Larva: Suborder Nematocera.* Up to 1/4", dark head, worm-like segmented body, 2 tiny legs on each side.

21 *Blackfly Larva: Family Simulidae.* Up to 1/4", one end of body wider. Black head, suction pad on end.

22 *Leech: Order Hirudinea.* 1/4" - 2", brown, slimy body, ends with suction pads.

23 *Pouch Snail and Pond Snails: Class Gastropoda.* No operculum. Breathe air. Shell usually opens on left.

24 *Other snails: Class Gastropoda.* No operculum. Breathe air. Snail shell coils in one plane.

Using the Mac[hole punch]nvertebrate Identification Key†

This key is designed to aid in the identification of different stream macroinvertebrates. This key (called a dichotomous key) consists of pairs of statements with opposite characteristics. To use this key, start at box 1 and read statements A and B. Then decide which statement best describes the organism and go to the next indicated box. Repeat this procedure until the macroinvertebrate group and page number are identified.

Information contained on the indicated pages should further validate this identification. If the organism has been misidentified, read through the section on similar macroinvertebrates and turn to the appropriate pages or return to this key and reconsider each appropriate statement.

If the macroinvertebrate is found in a portable case (usually constructed of pebbles, sand, small sticks, pieces of leaves or other vegetation), this case should be removed. In addition, it may be helpful to wash or remove any debris from the organism. It should be noted that a few characteristics may require the use of simple magnification to discern.

† for a definition of terms, please see Glossary

Key to Aquatic Macroinvertebrates Groups

Box 1

A. Has segmented (jointed) legs. .... Go to box 2

B. Does not have segmented (jointed) legs. .... Go to box 17

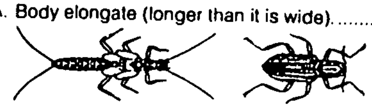
Box 2

A. Has only 6 segmented (jointed) legs .... Go to box 3

B. Has more than 6 segmented (jointed) legs. .... Go to box 14

Box 3

A. Body elongate (longer than it is wide). .... Go to box 4

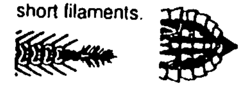


B. Body disk or oval shaped and flat. AQUATIC BEETLE LARVAE (water penny) (page 20)

Box 4

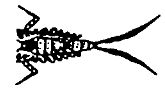
A. 2 or 3 distinct hairlike (may appear webbed) or broad (oar shaped) tails. .... Go to box 5

B. No tail, or a tail consisting of 1 single long filament, or hooked tails which may or may not have short filaments. .... Go to box 7

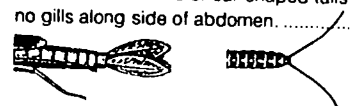


Box 5

A. Two or three hairlike tails (may appear webbed), gills along side of abdomen. MAYFLY LARVAE (page 14)

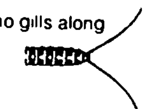


B. Two or three hairlike or oar-shaped tails with no gills along side of abdomen. .... Go to box 6

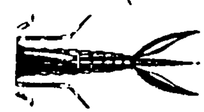


Box 6

A. Two hairlike tails, two antennae, no gills along sides of abdomen. STONEFLY LARVAE (page 13)



B. 3 broad oar shaped tails (sometimes hairlike) with no gills along sides of abdomen. DAMSELFLY LARVAE (page 18)



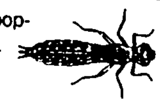
Box 7

A. Abdomen is hardened. Body is plated or skin is hardened. .... Go to box 8

B. Abdomen is soft, not hardened or plated. .... Go to box 9

Box 8

A. Wide abdomen, large eyes and large scoop-like lower lip that covers bottom of mouth. DRAGONFLY LARVAE (Page 18)

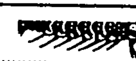


B. Whole body is hardened and stiff. Tail may have opening with tiny hooks and filaments extending. BEETLE LARVAE (page 19)

(From McCaferty 1983)

Box 9

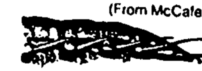
A. Fleshy or thin filaments extending from sides of abdomen. .... Go to box 10



B. No pairs of fleshy appendages extending from sides of body. Abdomen is fleshy. .... Go to box 13

Box 10

A. Fluffy or branched gill tufts under abdomen, short forked tail (with 1 pair of tiny hooks on each side). DOBSONFLY LARVAE (Hellgrammite) (page 16)



(From McCaferty 198

B. No gill tufts under abdomen, fleshy or thin filaments extending from the sides of the abdomen. .... Go to box 1

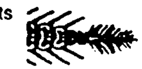
Box 11

A. No gill tufts under abdomen (smooth), short forked tail, fleshy or thin filaments extending from the sides of the abdomen. FISHFLY LARVAE (page 16)

B. No gill tufts under abdomen, abdomen either ends in a single long tail filament or comes to a point. .... Go to box 12

Box 12

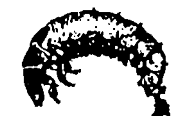
A. Single long tail filament, no gill tufts under abdomen. ALDERFLY LARVAE (page 16)



B. Abdomen comes to a point (with 4 very tiny hooks extending), no gill tufts under abdomen. BEETLE LARVAE (whirligig) (page 21)

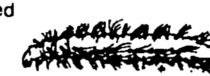
Box 13

A. Two small hooks on forked back end (may be hidden under leathery or branched tails). Underside of abdomen may have fluffy gills. CADDISFLY LARVAE (page 15)



(From McCaferty 1983)

B. Abdomen has pairs of caterpillar-like legs extending from abdomen, segmented body may be smooth or covered with filaments. AQUATIC CATERPILLARS (page 23)



(From McCaferty 1983)

Box 14

A. Body is lobster or shrimp like. .... Go to box 15

B. Armadillo shaped body, wider than high. Walks slowly. SOWBUG (page 25)

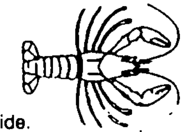
Box 15

A. Shrimp or lobster shaped body with thin plates forming a fan shaped tail. .... Go to box 16

B. Shrimp-like body no tail or tiny filaments extending from back end, body higher than it is wide. Swims quickly on its side SCUD (page 25)

Box 16

A. ... lobster-like with ten legs ...ding 2 large claws.
...YFISH (page 24)



B. Shrimp-like body, higher than it is wide. Pinchers (claws) are not greatly enlarged.
FRESHWATER SHRIMP (page 25)

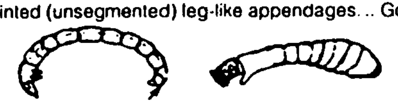
Box 17

A With a distinct head. .... Go to box 18

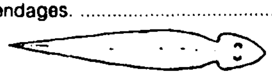
B. Without a distinct head. .... Go to box 22

Box 18

A. With distinct head and one or more very tiny non-jointed (unsegmented) leg-like appendages. .. Go to box 19



B. With distinct head and no legs or leg-like appendages. .... Go to box 21



Box 19

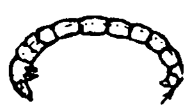
A. Very tiny (under 1/2 inch) body that may appear inchworm-like or widened at one end. .... Go to box 20

B. Distinct segmented body. Attachment disks on each segment along the center of the underside.
NETWINGED MIDGE LARVAE (page 29)

(From McCaferty 1983)

Box 20

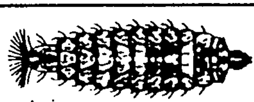
A. Both ends about the same width with one very tiny pair of legs under head and one very tiny pair under abdomen.
MIDGES (page 28)



B. Body widens at back end (vase-shaped), dark (usually black) head.
BLACK FLY LARVAE (page 27)

Box 21

A. Body is stiff with hard skin. Head is set off from body. Body is wider at upper end and tapers to a point. Body may have bristles or hairs.
SOLDIER FLY LARVAE (Page 29)



(From McCaferty 1983)

B. Flattened, unsegmented worm-like body, usually has distinct eye spots. Has gliding m...ent.
PLANARIAN (...33)

Box 22

A. Body has distinct legs or leg-like appendages, but no visible head. .... Go to box 23

B. Body without legs or leg-like appendages, and no visible head. .... Go to box 24

Box 23

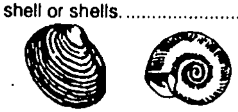
A. Two feathered horns at back end, caterpillar-like legs.
WATERSNIPE FLY LARVAE (page 27)

B. Variable number of short fleshy extensions from back end, extensions not feathered. Caterpillar-like legs.
DANCE FLY LARVAE (page 29)

Box 24

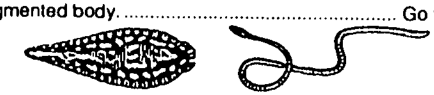
A. Body without hard shell. .... Go to box 25

B. Body with hard shell or shells. .... Go to box 29

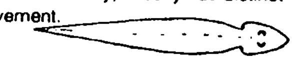


Box 25

A. Segmented body. .... Go to box 26



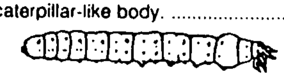
B. Unsegmented, flattened worm-like body, usually has distinct eye spots. Has gliding movement.
PLANARIAN (Page 33)



Box 26

A. Worm-like body that may or may not have suckers at each end. .... Go to box 27

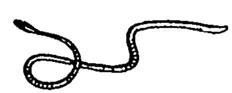
B. Soft, plump caterpillar-like body. .... Go to box 28



Box 27

A. Segmented body with suckers at each end, swimming or end to end movement.
LEECH (page 32)

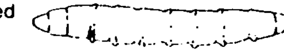
B. Long, segmented body; earth worm or thread like.
AQUATIC WORM (page 33)



Box 28

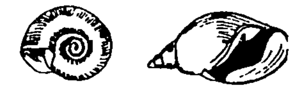
A. Caterpillar-like body with fleshy, finger-like extensions from one end.
CRANE FLY LARVAE (page 26)

B. Caterpillar-like body, tapered to a point at both ends.
HORSE and DEER FLY LARVAE (page 29)



Box 29

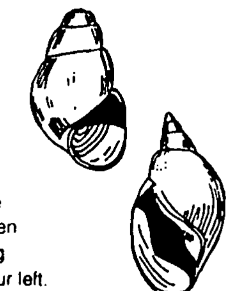
A. Single spiral, coiled or hat shaped shell. .... Go to box 30



B. Body enclosed within two hinged shells.
CLAMS and MUSSELS (page 31)

Box 30

A. Has plate like cover over opening. When spire is pointed up and shell opening faces you, shell usually opens on your right.
GILLED SNAIL (page 30)



B. Does not have plate like cover over opening. Shell is spiral, coiled in one plane or dome shaped. If coiled, when spire is pointed up and shell opening faces you, shell usually opens on your left.
PULMONATE (LUNGED) SNAILS, LIMPETS (page 30)

Appendix C-4
Biological Sheet

MACROINVERTEBRATE COUNT

(based in part on the Save our Streams Program, Izaak Walton League of America)

Sample using the riffle or the muddy bottom method. For riffle method, test 3 habitats within a 30-foot area to ensure you have a truly representative sample. Record each sample separately or the one which gives the best diversity. For muddy bottom, method take 20 scoops in each of the four habitats outlined in the manual.

Habitat selected for sampling:

- ☐ riffle
- ☐ leaf pack/woody debris
- ☐ streambed with silty area (very fine particles)
- ☐ streambed with sand or small gravel
- ☐ vegetated bank
- ☐ other (specify) ____

Use letter codes (A=1-9, B=10-99, C=100 or more) to record the numbers of organisms found in a 3 foot by 3 foot area riffle area . Then add up the number of letters in each column and multiply by the indicated value. The following columns are divided based on the organism's sensitivity to pollution.

SENSITIVE	SOMEWHAT-SENSITIVE	TOLERANT
☐ caddisfly larvae	☐ beetle larvae	☐ aquatic worms
☐ hellgrammite	☐ clams	☐ blackfly larvae
☐ mayfly nymphs	☐ crane fly larvae	☐ leeches
☐ gilled snails	☐ crayfish	☐ midge larvae
☐ riffle beetle adult	☐ damselfly nymphs	☐ pouch snails
☐ stonefly nymphs	☐ dragonfly nymphs	
☐ water penny larvae	☐ scuds	
	☐ sowbugs	
	☐ fishfly larvae	
	☐ alderfly larvae	
	☐ atherix	
☐ # of letters times 3 = ________ value +	☐ # of letters times 2 = ________ value +	☐ # of letters times 1 = ________ value +

Now add together the three index values = _____ total index value.

The total index value will give you an indication of water quality of your stream. Good water quality is indicated by a variety of different kinds of organisms, with no one kind making up the majority of the sample.

WATER QUALITY RATING

☐ Excellent (>22) ☐ Good (17-22) ☐ Fair (11-16) ☐ Poor (<11)

Return to:
Georgia Adopt-A-Stream
EPD
7 MLK Dr. Suite, 643
Atlanta, GA 30334

Appendix C-5

HOW TO MAKE A KICK SEINE

For collecting macroinvertebrates
(courtesy of the Tennessee Valley Authority)

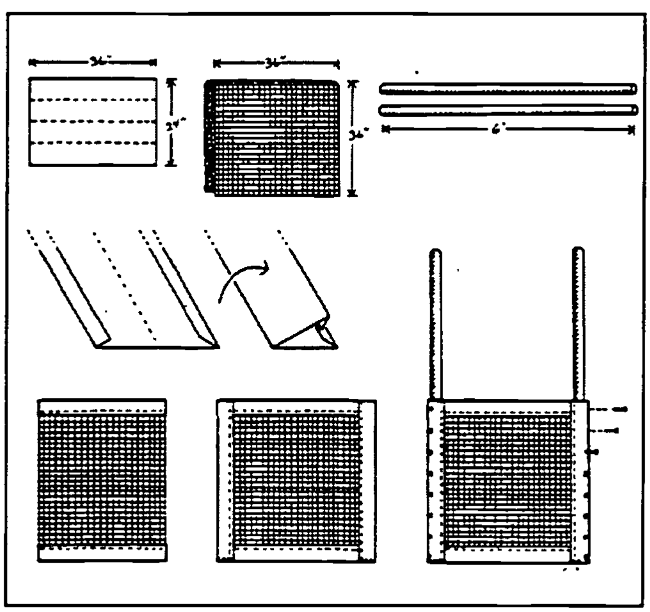
Materials:

3 foot by 3 foot piece of nylon or metal window screening
4 strips of heavy canvas (6 inches by 36 inches)
2 broom handles or wooden dowels (5 or 6 feet long)
finishing nails
thread
sewing machine
hammer
iron and ironing board

1. Fold edges of canvas strips under, 1/2 inch, and press with iron.
2. Sew 2 strips at top and bottom and then use other 2 strips to make casings for broom handles or dowels on left and right sides. Sew bottom of casings shut.
3. Insert broom handles or dowels into casings and nail into place with finishing nails.

Speed method:

1. Lay 3 foot by 3 foot piece of screening over broom handles.
2. Staple or nail screen to broom handles.



Appendix D-1
Why Are Chemical Tests Important?

(based on the Citizen Monitoring Handbook, published by the LaMotte Company)

This section describes some chemical and physical tests you can conduct and why they are important. Physical/Chemical testing should be conducted at least once a month because this type of testing measures the exact sample of water taken, which can vary weekly, daily or even hourly. A basic set of tests includes temperature, dissolved oxygen, pH, and settleable solids. Test kits that measures these four parameters will cost approximately $130.00. Replacement chemicals are inexpensive and will be needed after one year. Advanced tests include total alkalinity, ortho-phosphate and nitrate. A test kits that includes both basic and advance tests costs approximately $280.00. Some groups may wish to work with a certified laboratory to sample for fecal coliform bacteria or chlorophyll a.

TEMPERATURE

Water temperature is one factor in determining which species may or may not be present in the system. Temperature affects feeding, reproduction, and the metabolism of aquatic animals. A week or two of high temperatures may make a stream unsuitable for sensitive aquatic organisms, even though temperatures are within tolerable levels throughout the rest of the year. Not only do different species have different requirements, but optimum habitat temperatures may change for each stage of life. Fish larvae and eggs usually have narrower temperature requirements than adult fish.

Measuring Temperature

A thermometer protected by a plastic or metal case should be used to measure temperature in the field. Record air temperature by placing the dry thermometer in the shade until it stabilizes. Record the temperature of the air before measuring water temperature. To measure water temperature, submerge the thermometer in a sample of water large enough that it will not be affected by the temperature of the thermometer itself or hold directly in the stream.

Significant Levels

Temperature preferences among species vary widely, but all species can tolerate slow, seasonal changes better than rapid changes. Thermal stress and shock can occur when water temperatures change more than 1° to 2°C in 24 hours.

Many biological processes are affected by water temperature. Temperature differences between surface and bottom waters help produce the vertical water currents which move nutrients and oxygen throughout the water column.

What Measured Levels May Indicate

Water temperature may be increased by discharges of water used for cooling purposes (by industrial or utility plants) or by runoff from heated surfaces such as roads, roofs and parking lots. Cold underground water sources, snow melt and the shade provided by overhanging vegetation can lower water temperatures.

pH

The pH test is one of the most common analyses in water testing. An indication of the sample's acidity, pH is actually a measurement of the activity of hydrogen ions in the sample. pH measurements are on a scale from 0 to 14, with 7.0 considered neutral. Solutions with a pH below 7.0 are considered acids, those between 7.0 and 14.0 are designated bases.

The pH scale is logarithmic, so every one-unit change in pH actually represents a ten-fold change in acidity. In other words, pH 6 is ten times more acidic than pH 7; pH 5 is one hundred times more acidic than pH 7.

Significant Levels

A range of pH 6.5 to pH 8.2 is optimal for most aquatic organisms. Rapidly growing algae or submerged aquatic vegetation remove carbon dioxide (CO2) from the water during photosynthesis. This can result in a significant increase in pH levels. Low or high pH can effect egg hatching, kill sources of food for fish and insects, or make water impossible for any aquatic life to survive. In Georgia, Mountain and Piedmont streams will have pH ranges of 6.0 to 8.0. Coastal black water streams will naturally have more acidic conditions, with pH values of 3.5 to 6.0.

pH values of some common substances:

pH	
0.5	battery acid
2.0	lemon juice
5.9	rain water
7.0	distilled water
8.0	salt water
11.2	ammonia
12.9	bleach

DISSOLVED OXYGEN

Like land organisms, aquatic animals need dissolved oxygen (DO) to live. Fish, invertebrates, plants and aerobic bacteria all require oxygen for respiration.

Sources of Dissolved Oxygen

Oxygen dissolves readily into water from the atmosphere at the surface until the water is "saturated" (see below). Once dissolved in water, the oxygen diffuses very slowly, and distribution depends on the movement of aerated water by turbulence and currents caused by wind, water flow and thermal upwelling. Oxygen is produced by aquatic plants, algae and phytoplankton as a by-product of photosynthesis.

Dissolved Oxygen Capacity of Water

The dissolved oxygen capacity of water is limited by the temperature and salinity of the water and the atmospheric pressure (which corresponds with altitude). These factors determine the highest amount of oxygen dissolved in water that is possible.

Temperature Effect

As water temperature changes, the highest potential dissolved oxygen level changes.

Lower temperature = Higher potential dissolved oxygen level
Higher temperature = Lower potential dissolved oxygen level

The temperature effect is compounded by the fact that living organisms increase their activity in warm water, requiring more oxygen to support their metabolism. Critically low oxygen levels often occur during the warmer summer months when decreased capacity and increased oxygen demand, caused by respiring algae or decaying organic material, coincide.

Significant Levels

The amount of oxygen required varies according to species and stage of life. DO levels below 3 ppm are stressful to most aquatic organisms. DO levels below 2 or 1 ppm will not support fish; levels of 5 to 6 ppm are usually required for growth and activity. Fish and invertebrates that can move will leave areas with low dissolved oxygen and concentrate in areas with higher levels.

What Measured Levels May Indicate

A low dissolved oxygen level indicates a demand on the oxygen in the system. Pollutants, including inadequately treated sewage as well as decaying natural organic material, can cause such a demand. Organic materials accumulate in bottom sediments and support microorganisms (including bacteria) which consume oxygen as they break down the materials. Some wastes and pollutants produce direct chemical demands on any oxygen in the water. In ponds or impoundments, dense populations of active fish can deplete dissolved oxygen levels. In areas of dense algae, DO levels may drop at night or during cloudy weather due to the net consumption of dissolved oxygen by aquatic plant respiration.

High dissolved oxygen levels can be found where stream turbulence or choppy conditions increase natural aeration by increasing the water surface area and trapping air under cascading water. On sunny days, high dissolved oxygen levels occur in areas of dense algae or submerged aquatic vegetation growth due to photosynthesis. In these areas, watch for the lowest DO levels before sunrise each morning and highest levels just after noon.

SETTLEABLE SOLIDS

Settleable Solids refers to sediment and other matter suspended in fresh and salt water. Settleable solids is an easy, quantitative method to measure sediment and other particles found in surface water. An Imhoff cone (a plastic or glass 1 litter cone) is filled with one litter of sample water, stirred, and allowed to settle for 45 minutes. The solids settle in the cone and are measured as a volume of the total, in milliliters per liter. This measurement is a reproducible analogue to turbidity.

Excessive solids in water block sunlight and clog fish and macroinvertebrate gills. Sediment that settles on the streambed can smother habitat for fish and other aquatic life.

NUTRIENTS -- Nitrate and Phosphate

Eutrophication

The addition of phosphorus, nitrogen and other nutrients to a body of water results in increased plant growth. Over time, dead plant material builds up and, combined with sediments, fills in lakes and reservoirs. When excess nutrients and sediment are added, the speed of this natural process is increased significantly.

Plants, especially algae, are very efficient users of phosphorus and nitrogen. By the time an algae bloom is observed, the nutrients may no longer be measurable but may continue to impact the ecosystem. By sampling upstream from areas of algae blooms, the source of excess nutrients may be identified. Algae blooms will usually be found in lakes and reservoirs. If excessive algae are found in streams, the nutrient content is probably very high. The macroinvertebrate population will reflect a high input of nutrients--you will find little variety of macroinvertebrates but many of one or two kinds.

High flow rates in streams may prevent the establishment of floating aquatic plants and algae despite the presence of high levels of nutrients. As the summer progresses and flow rates drop, once rapidly flowing streams can become choked with algae. Wide, slow moving and tidal areas downstream may exhibit algae blooms weeks earlier.

Sources of Nutrients

Nitrogen and phosphorus enter water from human and animal waste, decomposing organic matter and fertilizer runoff. Phosphates also are found in some industrial effluents, detergent wastewater from homes, and natural deposits.

Measuring Nitrate

Nitrogen occurs in natural waters as nitrate (NO_3), nitrite (NO_2), ammonia (NH_3) and organically bound nitrogen. Nitrate test results are expressed as "nitrate nitrogen" (NO_3-N), meaning "nitrogen that was in the form of nitrate." Some test kits and the literature express levels only as nitrate (NO_3). Both expressions refer to the same chemical and concentrations, but use different units of measure:

Nitrate Nitrogen ppm x 4.4 = Nitrate ppm

Significant Levels

Unpolluted waters generally have a nitrate-nitrogen level below 1 ppm. Nitrate-nitrogen levels above 10 ppm (44 ppm nitrate) are considered unsafe for drinking water.

Phosphorus

Phosphorus occurs in natural waters in the form of phosphates - orthophosphates, polyphosphates and organically bound phosphates. Simple phosphate test kits measure reactive phosphorus (primarily orthophosphate) which is the form of phosphate applied as fertilizer to agricultural and residential lands.

Organically bound phosphates in water come from plant and animal matter and wastes. Organically bound phosphates and polyphosphates cannot be measured directly. They must first be broken down or "digested" by adding an acid and oxidizer

and boiling the sample. After the digested sample cools, an orthophosphate test is performed to measure total phosphorus. Results are expressed as phosphate (PO4).

Significant Levels

Total phosphorus levels higher than 0.03 ppm contribute to increased plant growth (eutrophication). Total phosphorus levels above 0.1 ppm may stimulate plant growth sufficiently to surpass natural eutrophication rates.

ALKALINITY

Alkalinity of water is its acid neutralizing capacity. It is the sum of all the bases found in a sample including carbonate, bicarbonate, and hydroxide content. The alkalinity, and therefore buffering capacity, of natural waters will vary with local soils.

WATER QUALITY CRITERIA FOR THE STATE OF GEORGIA

Waters in the state of Georgia are classified by use. For example, most streams, rivers and lakes are designated for "fishing" use. Other classifications include recreation, drinking, wild and scenic. Different protection levels are assigned to different uses. Thus drinking water may have stricter requirements for dissolved oxygen and temperature than water classified as primarily used for trout fishing.

All waters of the state should be "free from materials associated with municipal or domestic sewage, industrial waste or any other waste which will settle to form sludge deposits that become putrescent, unsightly, or otherwise objectionable".

There are numerous criteria for specific chemicals and metals. The general criteria for several parameters are listed below.

Fishing, Recreation and Drinking Water:

Dissolved Oxygen Daily Average
5.0 mg/l

Minimum
4.0 mg/l

Dissolved Oxygen for **Trout Streams:**

Daily Average
6.0 mg/l

Minimum
5.0 mg/l

pH Within range of
6.0 to 8.5

Temperature Maximum
90°F (32.2°C)

Nitrate No set standard
Phosphate No set standard

Appendix D-2
Easier Instructions for Dissolved Oxygen Testing

PLEASE PUT SAFETY GOGGLES AND GLOVES ON AFTER FILLING THE BOTTLES WITH SAMPLES BUT BEFORE PERFORMING DO TESTS.

1. **Rinse** out the **"water sampling bottle"** with stream water (Three times).

2. With the bottle empty, close the cap of the bottle tightly and place bottle in water, mid-stream. **The bottle should be at 1/2 of the water's depth.** Remove the cap and allow the bottle to fill with the mouth facing down. Gradually turn the bottle right side up and hold it at the sampling depth until it is filled. Fill the bottle to the brim and **cap while it is in the water**. Looking through the water, **make sure all the air is out of the bottle.**

4. Pull the bottle out of the water. Make sure there is no air bubbles by turning the bottle upside down. If there are air bubbles, sample the water again.

5. Place the bottle on a flat surface and remove the cap. Add:
   (1) **8 Drops of #1** (Manganous sulfate, pink solution in dropper bottle) then,
   (2) **8 Drops of #2** (Potassium Iodide Azide, clear solution in dropper bottle)
   Note: Do not touch dropper bottles to the samples.

6. Cap the bottle. **Turn the bottle upside down and right side up twenty-five times**, until brown particles appear in the water (precipitate). Allow the bottle to sit and the brown particles to settle below the shoulder of the bottle. Turn the bottle again upside down and right side up ten more times. Allow the bottle to sit and brown particles to settle below the shoulder of the bottle.

7. Uncap the bottle and add **8 drops of #3** (Sulfuric acid, the dropper bottle with the red cap). Cap the bottle and turn the bottle upside down and right side up **until the brown particles have completely dissolved**. The color will be yellow/orange/brown.

8. Rinse out the "20 ml marked glass vial", and add 20 ml of the above "yellow/orange/brown" sample to the fill line. Cover the vial with the plastic lid (hole in the middle).

9. Take the syringe (titrator) and place the plastic tip on the end. **Place the tip of the syringe into the #4 bottle** (Sodium thiosulfate, in the bottle with the black cap) and fill it to the "0" line. **Make sure there are no air bubbles in the syringe.**

   Note: **The lower, black tip of the plunger should be on the "0" mark.** The liquid should fill from the "10" to "0" mark.

10. Place the tip of the syringe into the hole of the plastic vial cap. Add one drop from the syringe into the vial, and swirl after each drop. Continue adding drops until the sample turns into a pale straw color. Uncap the vial leaving the syringe in the lid.

11. **Add 8 drops of #5** (Starch Solution, brown glass dropper bottle) into the vial. Recap with the plastic lid and swirl. **The solution will turn dark blue.**

12. **With the syringe, continue adding drops to the sample, swirling after each drop**. Using a white background wait for the sample to turn from **blue to clear**. **STOP** at this point. Using the scale on the syringe, take a reading where the lower black tip of the plunger hits. **Each small red line is for 0.2 ppm of oxygen.** The reading will tell you the amount of dissolved oxygen in ppm.
    Note: If the syringe runs out, take the syringe and re-fill with #4 (Sodium thiosulfate) and continue adding drops until the solution turns clear. Take the reading on the newly filled syringe and add 10 to the value. This is the amount of dissolved oxygen in the water.
    Any remaining solution in the syringe and the completed sample should be placed in the waste container.

To help students work with the dissolved oxygen test kits, label the chemicals as follows:

#1 Manganous Sulfate
#2 Potassium Iodide Azide
#3 Sulfuric Acid
#4 Sodium Thiosulfate
#5 Starch Solution

By labeling the reagents, students can add the chemicals by following the numerical order. This decreases the changes for error when performing the test.

Appendix D-3
Chemical Sheet

GEORGIA ADOPT-A-STREAM
Biological and Physical/Chemical Survey

Use this form and the Adopt-A-Stream methods to record important information about the health of your stream. By keeping accurate and consistent records of your physical/chemical tests and data from your macroinvertebrate samples, you can document current conditions and changes in water quality.

Name of Stream
Location

Individual or group
Members present
QA/QC Certified Volunteer Present?

Date
County

Weather conditions
☐ clear ☐ cloudy ☐ rain
☐ rain within last 24 to 48 hours?

PHYSICAL/CHEMICAL TESTS

		Sample 1	Sample 2	
BASIC TESTS				
Air Temperature	________	________ (°C)		
Water Temperature	________	________ (°C)		
pH		________	________	(1-14)
Dissolved Oxygen	________	________ (mg/L)		
Settleable Solids	________	________ (mg/L)		
ADVANCED TESTS				
Total Alkalinity	________	________ (mg/L)		
Nitrate		________	________	(mg/L)
Ortho-phosphate	________	________ (mg/L)		
LAKES				
Clarity (Secchi Disk Depth)		________	________	(meters)

Special Lab Analysis Name of laboratory preforming tests ________________

	Sample 1	Sample 2	
Fecal Coliform	________	________	(per 100 mL)
Chlorophyll A	________	________	(mg/L)

COMMENTS ________________

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Organization/Address: GA Adopt-A-Stream 4220 International Pkwy suite 101 Atlanta GA 30354	Telephone: 404-675-1636	FAX: 404-675-6245
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